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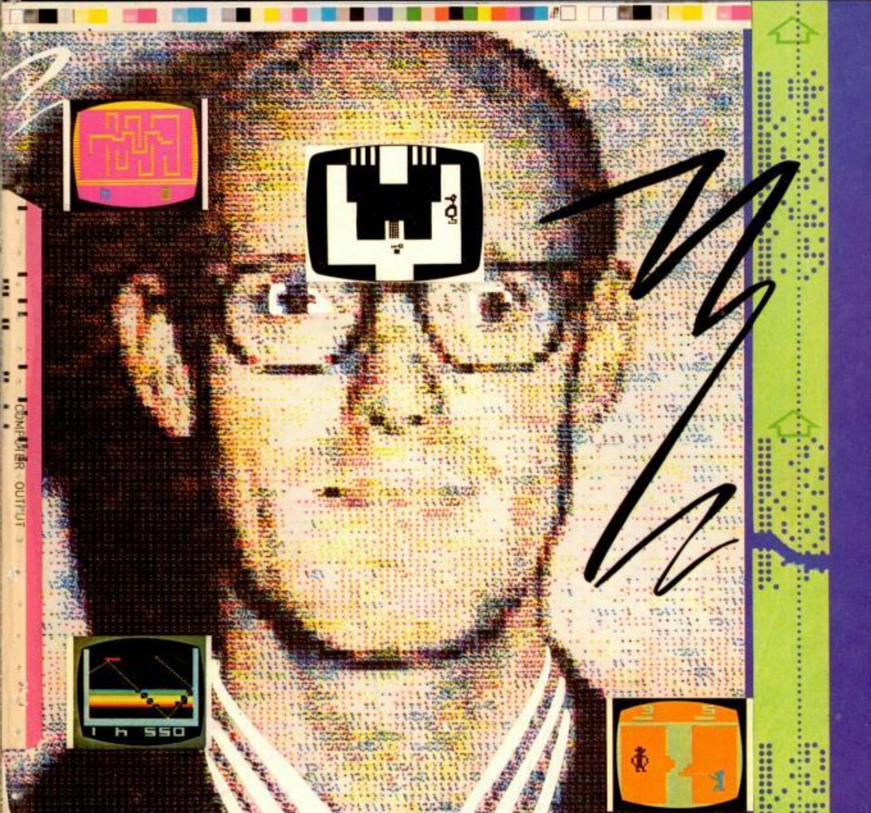

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Computer criminals are often portrayed as highly intelligent people who defraud the computer "because it is there". Jay Becker sees things differently, and on p 818 he tells us who and what sort of people really commit computer crimes.

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Comment

Middle East harassment

Many of the problems of scientists in the Middle East—lack of funds, scarcity of equipment, poor quality of technical back-up, and so on—are well known. However, it is not widely appreciated that they live and work under continuous harassment and constant threat to their lives.

The death sentence on the Iraqi atomic scientist, Dr Hussain Shahristani, reported in *New Scientist* last week, is just one example. Shahristani has since been reprieved but he remains in prison, awaiting some kind of show trial. Meanwhile, another atomic scientist, Dr M. D. Jaffer, head of the Experimental Physics Department of the Iraqi Atomic Energy Authority, has been missing for six weeks. Scientists coming out of Iraq report a state of terror as the General Security Organisation steps up its activities to purge the Iraqi science community of "reactionary and religious activities".

Iraq is not the only Arab country to treat its scientists in this way. Throughout the Middle East science is suffocated by vicious bureaucratic harassment, political persecution and intimidation, and suppression of the inquiring spirit that is the essence of science. Presentation of scientific alternatives or plans that go against the dictates of the ruling elites, or criticism of government science policies, bring swift and harsh reprisals.

Perhaps the most tragic sign that all is not well in the Middle East is the lot of Third World scientists working in the oil-rich Arab states. Mostly from Egypt, Pakistan, India and Korea, they have a third-class status (below nationals and Western expatriates). The humiliation and psychological and physical suffering they are subjected to makes one wonder whether the rulers of Libya, Saudi Arabia and the Gulf Sheikdoms have ever heard of the UN Declaration of Human Rights, let alone the lofty ideals of Islam that they claim to profess.

Scientists in the West have campaigned for the rights of their colleagues in the Soviet Union and Eastern Europe, but they seem to ignore far worse treatment of scientists in the Middle East. Western science consultants and advisers exercise, and have exercised for decades, considerable influence on governments in the Middle East. So far, this influence has been used only to sell technology and grandiose plans. Is it too much to hope that the scientific community in the West could direct some of this influence toward securing a little freedom for scientists in the Middle East? **Ziauddin Sardar**

Safe unions

The sleeping giant is beginning to stir. Yesterday, the National Union of Agricultural and Allied Workers repeated the Trades Union Congress's recent call for a ban on the pesticide 2,4,5-T. With a few scientists' help the union is gradually acquiring the scientific literacy it needs to protect its members against the "side-effects" of pesticides and other agricultural chemicals. This week, Clive Jenkins's Association of Scientific, Technical and Managerial Staffs (ASTMS) launches a concerted and planned attack on the problem of cancer-causing chemicals in the workplace. With the assistance of a few scientists, the union has developed a strategy for controlling carcinogens. This strategy demonstrates an unusually adept handling of the complex relationships between science and public policy. ASTMS will call for managements to spare no expense in eliminating carcinogens from the workplace and will call on its members to negotiate "no carcinogens" agreements.

Having taken up the issue of 2,4,5-T, the TUC is poised to turn its attention to the hazards of radiation. Indeed, the TUC has already expressed some reservations about current safety standards protecting workers against the cancers that radiation causes. Whether the TUC supports or opposes the expansion of Britain's nuclear power programme, it is certain to push for stricter safety standards. However, the science behind these safety standards is contentious and confused. The TUC needs—and to some extent is receiving—aid from some scientists in assessing the evidence in this crucial debate. Trade unionists are beginning to attend conferences on radiation safety, and to organise their own meetings. The TUC itself would do well to consider the idea of organising its own conference on the hazards of radiation.

All this activity—after years of comparative neglect—is hardly surprising. The hazards created by post-war technologies are coming home to roost. The 1974 Health and Safety at Work Act, and particularly the creation of trade union safety representatives under that act, has helped to jerk the unions into action. Crucially, some of the scientists studying hazards are beginning the slow descent from their ivory towers; and are finding that their science is enriched in the process. When confronted with the sharp realities of a union trying to define a policy toward the hazards they have been studying, scientists suddenly discover new perspectives and, in particular, realise the limitations of their science. **Lawrence McGinty**

Heartless questions

What is the DHSS doing, agreeing to pay for heart transplants? With one exception—a team at Stanford University in California—almost every surgeon in the world who has tried this operation has willingly abandoned it as impractical. No doubt, given the same 20 years to practise, British surgeons could be just as good at heart transplants as the ones at Stanford where surgeons are now saving 25 lives a year, at a total cost of $1 million, with the operation.

As many as 30 people a year in Britain might be eligible for heart transplants. Why is it that no one is willing to talk of letting those 30 die this year, when they would have two years ago, before British surgeons decided to give transplants another try? Could this have anything to do with publicity? All the people who die on waiting lists, or while waiting for an ambulance, or because of staff shortages—you rarely see front-page photos and two-inch headlines about them, even though they outnumber candidates for heart transplants. There will never be enough money to save everyone medical science knows how to save. Has the DHSS thought about trying to save the most people for its money?

"The money" is, conservatively, £25 000 for each operation and £15 000 for the first year after surgery. Money spent on heart transplants will come out of something else in the long run, but we will never know what. We can only speculate what will suffer; probably research that is already difficult to justify to the public, say bioengineering toward a left-ventricle assist device (not the sort of thing headlines are made of) or research into the causes of heart disease in the population. Perhaps an anti-smoking campaign. Do we dare mention that the same DHSS is already planning to close London hospitals for lack of money?

It seems a pity that the DHSS cannot wait a few years for the Americans to ascertain—at their expense—whether heart transplants are the solution of the future for failing hearts. **Lois Wingerson**

This week

Third World still hooked on Western drugs

Karl Hammond, Mozambique

The marketing of inappropriate and potentially toxic drugs in the Third World continues, despite much publicity about the hazards of the practice. The latest story comes from Mozambique and concerns Cibalgin, a Swiss-made analgesic frequently taken here for headaches. It was sold over the counter throughout Mozambique. The drug may kill—indirectly—by reducing the victim's resistance to other infections.

The story of Gail C illustrates the dangers of mixing two kinds of medicine—the basic health-care system the Mozambican government is building and the "take-our-pill" approach the free enterprise health industry promotes. Despite the strenuous efforts of the government to encourage prevention rather than cure, the country is still saddled with a desperately inadequate health system, left behind by the departing Portuguese rulers.

Gail C—a Briton in Beira—began to suffer headaches. Like many people in Beira, where she was working, she went to a local pharmacy for advice, rather than take time off work for a "consulta" with a doctor at the local health centre. The pharmacist had just the thing, Cibalgin. She bought a packet of 20 and started taking them according to instructions.

Gail's headache did not get better. When, after a week, she developed a sore throat and fever, she took a large dose of chloroquine, the reflex response of health workers and lay people alike in malaria-ridden Beira to headaches, fever and even diarrhoea. Her condition grew rapidly worse and a course of antibiotics did not help. She was plagued by cold sores. Two weeks after first visiting the pharmacy, she was running a temperature of over 40°C, her face had swollen beyond recognition and her gums were turning black. Infections developed along the veins of her arms and she was too weak to stand. Two days later she was admitted to hospital after a test showed that the number of white cells in her blood was a fifth the "normal" level.

Today Beira, Mozambique's second city, still enjoys a far better standard of health care than most of the country. But there are still only 25 doctors for a population of 300 000. And Beira has no laboratory facilities to diagnose anything more complicated than the simplest parasitic and bacterial diseases. For example, there was no means of discovering whether a virus caused Gail's agranulocytosis—the pathological depression of her white blood cell count.

So serious was Gail's condition that she was flown to Johannesburg with a minimum of contacts and isolated in the fever hospital. There she came under the care of a team from the National Institute of Virology, which included international authorities on the exotic arboviruses, such as Lassa fever or Marburg disease, which could not be ruled out as a cause of Gail's illness.

By now, Gail's condition was critical. The infection which started in her mouth had erupted all over her body and doctors found abscesses on her lungs too. The flesh of her lips and gums fell away, quite diseased, as was part of the exposed jawbone. The Johannesburg team ran a battery of tests, but it failed to find any viral explanation of Gail's condition and succeeded only in diagnosing the unusual bacteria responsible for the secondary infections.

Having eliminated a viral cause for the dramatic reduction in Gail's white cell count, the team next asked what drugs she had taken. She mentioned Cibalgin. There was no need to look any further. The active ingredient of Cibalgin, amidopyrine, was first shown to cause agranulocytosis 58 years ago. And it is this fall in white blood cells that left Gail vulnerable to potentially fatal secondary infections.

"We try to conform with local legislation, Signorina Borgia."

Amidopyrine is a textbook example of a disease-causing drug. Authorities say: "amidopyrine carries too big a risk of agranulocytosis to be useful as a mild analgesic" (*Drug Induced Diseases*, Excerpta Medica Foundation, vol 3, p 316). Dr N. C. Hugh-Jones says in his *Lecture Notes on Hematology:* "The first drug to be incriminated [in agranulocytosis] was amidopyrine, and although the compound is no longer prescribed it is still available in some proprietary preparations in certain parts of the world". The package of Cibalgin that Gail bought was labelled for sale in countries such as Nicaragua, El Salvador and the Netherlands Antilles.

In the developed world, drug authorities placed amidopyrine under prescription control in the United States as early as 1938, and banned it entirely in Australia in 1964. Research in animals showed that the interaction of amidopyrine and nitrites in the stomach may produce a carcinogenic substance, dimethylnitrosamine. Consequently, amidopyrine was withdrawn from all analgesic and antipyretic preparations in West Germany, Japan and Switzerland. Amidopyrine was recently withdrawn from sale in Sweden and Britain.

Despite the well-documented risks of amidopyrine, a representative of Ciba, one of Switzerland's three largest pharmaceutical companies, was still promoting Cibalgin actively in Mozambique in the past year or two. Only weeks after Gail had been evacuated from Mozambique, a Ciba salesman arrived in the Central Hospital of the capital Maputo to distribute free samples. He pooh-poohed queries about the drug's side-effects, saying they were greatly exaggerated.

Ciba's marketing of the drug conforms, it must be said, to the letter of the law of Mozambique, which awaits complete revision. Just how closely Ciba follows the letter of the law rather than the spirit is shown by its reply to a letter informing it of the side-effects of Cibalgin which had been noted in Gail's case. "We thank you for your interest in our product," the Swiss head office replied.

Gail was lucky. Back in Britain, she is recovering well. Her only problem is that the mouth infection so weakened her jawbone that she may have to wait years until it is strong enough to enable doctors to carry out oral surgery to repair the damage.

The import and sale of Cibalgin and other dangerous drugs in Mozambique will, in time, be ended as the country develops and implements its health policy. Cibalgin is not on the list of essential drugs set out by the World Health Organisation, which will in future govern the purchases of MEDIMOC, the state pharmaceutical organisation.

The private pharmacies still handle a large proportion of drug sales. But the state will probably take them over, which should permit greater control over the products they sell.

A Ciba spokesman said that the company no longer manufactures any preparation containing amidopyrine, preferring instead a new ingredient, propyphenazone. Moreover, he claimed that Ciba passed information on this new ingredient to Mozambique in 1978. If the old formulation is still being sold, he said that the long lines of communication between Ciba and its salesmen in the Third World explains the lag. But, according to drug experts, there is little documented evidence to show that propyphenazone is any safer (or more dangerous) than amidopyrine with regard to agranulocytosis. □

Road traffic computer jams up

Mick Hamer

The Department of Transport has spent over £7 million on a computer model—the Regional Highway Traffic Model—that has proved to be unusable. The latest, unpublished, report from the Advisory Committee on Trunk Road Assessment (the Leitch committee) is believed to condemn the model as useless.

The Department of Transport (DTp) justifies building new roads by forecasting the amount of traffic that will use them. But in the early 1970s, as new road building became increasingly controversial, the DTp was severely embarrassed at a series of public inquiries into new roads when objectors successfully challenged its traffic forecasts.

The road builders' answer was to centralise their traffic forecasting. Thus was the Regional Highway Traffic Model (RHTM) conceived. The DTp (advised by independent consultants) designed the RHTM to be a national traffic model that could forecast traffic flows on any hypothetical network of roads for any year in the future. This last aspect is particularly important because the DTp justifies roads on the basis of the traffic it expects them to carry 15 years after being opened.

However, on its trial run the RHTM proved an abysmal failure. To validate the model, the DTp asked it to "forecast" traffic flows on existing trunk roads. Despite engineers spending more than two years making adjustments to the model, its "forecasts" for existing roads can still be wrong by a factor of two. It is believed that the Leitch committee has now told Transport Minister Norman Fowler that the RHTM is unreliable.

The RHTM is based on the gravity model, which is founded on an analogy to Newton's law of gravitational attraction. In its simplest form, the gravity model assumes that the frequency of trips between two centres of population is directly proportional to the product of the two populations and inversely proportional to a function of the distance separating the two centres.

In the RHTM this relatively simple assumption is weighted down with considerable complications. The modellers divided England into some 3500 zones and took into account demographic characteristics and patterns of land-use in each zone. Subsidiary models to RHTM relate population, employment and land use to the rate of trips generated. The main growth factor in RHTM is the expected increase in car ownership. In the final stages, RHTM assigns traffic flows to a particular road network.

It is relatively easy to change the factors in simpler models, with only a few dozen zones, to produce a reasonable reflection of known traffic flows. But with 3500 zones in the RHTM, this proved impossibly complex.

Keystone

Announcing the RHTM in 1975, Dr John Gilbert, then Minister of Transport, said that the project would require "mounting a series of roadside and home interviews on a scale never previously attempted". These surveys accounted for much of the project's £7 million price tag. But the Leitch committee's report concludes that the mass of statistics these interviews generated—which is now four years out of date—is only of limited use. ☐

Physics centre for Third World threatened

Ziaddun Sardar

The much-acclaimed International Centre for Theoretical Physics in Trieste is facing an acute financial crisis. According to the centre's founder-director, Nobel laureate Abdus Salam, without an immediate injection of funds, it may "sink". For over a year now, Salam has been sending desperate "SOS messages" to governments and funding bodies—without much luck.

Cash shortages have forced the centre to reduce its staff to a part-time director, a few secretaries and a handful of consultants. And future prospects for the centre's main activity—financing visits from Third World physicists—look gloomy.

Many of the centre's financial problems are a result of world recession and inflation. In its first year, 1964, the centre played host to 150 visitors and a budget of $325 000 was adequate. But in 1979, 1200 scientists, 600 from developing countries, visited the centre for roughly two months each. A budget of $1·8 million is now not enough to sustain the activities that have developed at the centre over the past 15 years.

Funds for the centre come from the International Atomic Energy Agency ($750 000 a year) and the Italian government ($700 000 a year). UNESCO gives $300 000 a year and the Swedish government donates some $60 000 a year toward the centre's running costs.

Salam is looking for another $2 million to maintain the quality and spread of activities of the centre. Salam's main hope is for a grant from the Interim Fund for Science and Technology for Development (IFSTD), which the UN is to set up after its Conference on Science and Technology for Development last year in Vienna. The pledging conference for IFSTD will take place at the UN in New York on 28 March. Salam hopes that his SOS messages to the UN Development Programme, which will administer the new fund, will bear fruit.

The Italian government is Salam's second hope. The Italian contribution to IFSTD will probably be $4 million. Salam hopes to persuade the Italians to give half of this *directly* to his centre to strengthen its research on energy.

Ironically, the financial problems of the Trieste centre come at a time when several other international centres of excellence are being planned on the Trieste model. Indeed, Salam himself has helped to found a number of these centres in the past few years. The International Centre for Mathematics in Udine, in northern Italy, has been operating for five years and is a direct result of his efforts. Recently, he has also been involved in setting up the International Centre for Pure and Applied Mathematics in Nice and the International Centre for Physics in Mexico City, which opened on 22 February.

Salam has generated considerable interest in the idea of international centres in Latin America. Four international centres in Latin America are on the drawing board: a centre studying alternative energy sources in Brazil; one for mineral technology in Peru; one specialising in solar energy in Colombia and one for postgraduate sciences in Venezuela. Peru is also planning a centre in Cusco for Third World scientists to carry out advanced studies.

The centre for postgraduate sciences in Venezuela, which will, in effect, be an international university with students from the Third World, seems almost certain to be set up soon. Venezuela has generated considerable enthusiasm among OPEC countries for the idea and President Herrera of Venezuela, an influential voice among the oil-producing nations, was in Vienna earlier this week trying to persuade OPEC to back the centre.

"It is ironic," notes Salam, "that while the concept of international centres of excellence to promote the development of science in the Third World is spreading and many new centres are about to get off the ground, the original model may actually sink for lack of funds." ☐

Is the Finniston report being shelved?

John Stansell

The major recommendation of Sir Monty Finniston's committee of inquiry into engineering looks like being shelved. The main conclusion of Finniston's committee, after almost two years investigating the engineering profession, is that the government should set up an Engineering Authority to register engineers, to speak on their behalf and to inject an "engineering dimension" into British industry.

But the engineering establishment is against the new authority. Supporters of Finniston's recommendations feel that this opposition has struck a sympathetic chord among the Department of Industry civil servants who will advise the Secretary of State for Industry, Sir Keith Joseph, on the implementation of Finniston's report, which was published six months ago.

Finniston himself believes that it is by no means certain that the government will decide to create the new authority. He says that most engineers and industrialists would like to see an authority set up, but so far only those who oppose the idea have made their voices heard. The Department of Industry (DoI) is collecting opinions about Finniston's report until 1 April. Unless the department receives a resounding "yes" to the idea of an Engineering Authority by then, Finniston believes it is unlikely to press ahead with the legislation needed to set up the new body.

The much-criticised Counsel of Engineering Institutions (CEI)—which the new authority would replace—has marshalled the most vehement opposition to the Finniston report. Recently, it circulated a private memo to its member engineering institutions calling for them to present a consensus view to the DoI. The CEI says that implementing Finniston's recommendations would mean unnecessary and damaging upheaval. It claims that an authority appointed by the government would take the regulation of the engineering profession out of engineers' hands and that the new authority would be yet another, expensive quango.

The CEI wants three separate bodies instead of the single engineering authority Finniston proposes. One would be a more powerful version of the existing Engineering Registration Board with the blessing of a royal charter. It would have a governing board of nominees from the engineering institutions, employers, unions and the universities, sitting with three representatives elected by engineers themselves. It would formally register engineers as it does now.

A second body, which the CEI calls Body X, the Association of British Engineers or the Society of Engineers, would speak on behalf of all engineers —and, by the CEI's own admission, "more effectively than [the CEI has] in the past". Yet another organisation—Body Z—would be, in Finniston's words, "the engine of change" needed to jolt British industry into action.

Supporters of Finniston's proposals fear that their most powerful and dangerous opponents are the civil servants in the Department of Industry who have traditional links with the group of institutions concerned with construction—the civils, structurals and municipal engineers.

Finniston's main allies are industrialists such as Sir Terence Beckett of Ford, Sir Robert Clayton of GEC, Sir Kenneth Corfield of STC and Sir Bill Barlow of the Post Office—engineers who are now top managers. All are concerned about the current opposition to Finniston's proposals. Clayton, for example, has personally visited Michael Marshall, the junior minister in the DoI collating opinions on Finniston's proposals, to declare his support for the new authority. ☐

SRC to change its name?

The Science Research Council intends to make a strong bid to become the main body directing research and education in engineering in Britain—whether or not the government implements the recommendations of the Finniston committee of inquiry into engineering. The SRC may even change its name—perhaps to the Science and Engineering Research Council—to reflect this new emphasis. And this week Sir Geoffrey Allen, chairman of SRC, told *New Scientist* that the council would expect more money from the government, perhaps as much as £15 million a year, if it is to expand its influence on engineering research.

Allen sees an expansion of SRC's interests in engineering as a natural extension of its current efforts to forge links between industry and university research. The SRC already has special directorates for marine technology and polymer engineering and supports the "teaching company" scheme, in which postgraduate students divide their time between university and industry. Its CASE (Cooperative Awards in Science and Engineering) scheme also tries to give students industrial experience. More recently, the SRC has backed—to the tune of £1 million—24 projects involving industry/university collaboration at a more senior level. ☐

Walker lets dairy farmers off the hook

Nick Davidson

Four thousand dairy farmers in England and Wales breathed a huge sigh of relief last week when Peter Walker, Minister of Agriculture, Fisheries and Food, announced that he would not ban the public sale of untreated milk. His decision is the successful culmination of a sustained campaign by the National Farmers' Union (NFU), but may be a more uncertain victory for milk drinkers. For untreated milk may not be as full of natural goodness as the dairy industry's advertising suggests.

Five years ago, the Labour government announced plans to ban all sales of untreated milk to the public. The plans were supported by a large body of medical opinion, but ran into strong opposition from the NFU which argued that many farmers would go out of business if the government imposed a ban. The government agreed to put off the day of reckoning until 1983.

Last year the new Conservative government re-opened the issue. It is now clear that Walker has accepted a large part of the farmers' case. Although he has banned the sale of untreated milk to shops, canteens and so on after 1985, individuals will still be able to buy it. George Younger, the Secretary of State for Scotland, has, however, decided to discourage the sales of untreated milk in Scotland after 1983.

The medical arguments for treating—pasteurising—milk are pretty clear-cut. Untreated milk spreads several diseases and infectious agents such as TB, brucellosis and *Salmonella*. More rarely, it can also spread other diseases and infectious agents such as Q-fever, *Campylobacter*, *Staphylococcus* and *Escherichia Coli*. Pasteurisation eliminates all these infectious agents.

Pete Addis

The NFU argues that the 3 per cent of untreated milk sold in Britain represents a negligible threat to public health. "It is an unfortunate but practical fact of life that eating virtually any food stuff carries with it some risk of infection," it says. The NFU also points out that rigorous farm hygiene has eliminated fresh milk as a cause of some of the more serious infections, such as TB and brucellosis, and that the remaining diseases are relatively rare. Between 1976 and 1978 there were 30 recorded *Campylobacter* infections and over 400 cases of *Salmonella* poisoning traced to untreated milk (about 7 per cent of all recorded *Salmonella* cases). The other infections are rare, but records are probably inaccurate because the comparative rarity of the diseases means that they might be misdiagnosed.

Pasteurisation has proved an effective and cheap way of making milk safe: it has reduced the toll of infant deaths from TB directly attributed to milk from 2500 a year to virtually nil. ☐

Can Britain cope with oil spills?

The men who operated equipment to contain oil spilling from the capsized ship Tarpenbek off the Isle of Wight last summer were so disgusted by the way the government's representatives handled the incident that they had T-shirts printed carrying the message "Tragic Circle Club". They were protesting about the decision by the regional "principal officer" of the Department of Trade's Marine Pollution Control Unit (MPCU) to encircle the wreck with 500 metres of booms to hold back the oil, against the advice of engineers from BP, the company that made the booms. No one was surprised when the oil repeatedly broke through the cordon of booms.

Last Friday, David Harper, managing director of Harrier Marine—a company that makes equipment for containing and cleaning up oil spills—bitterly attacked what he called the complacency of the MPCU and the reluctance of its director, Rear Admiral Michael Stacey, to take expert advice. Speaking on the last day of the Oceanology International 80 conference in Brighton, Harper said that the inappropriate use of booms to contain spills from the Tarpenbek and the Christos Bitas, which was holed off the Pembroke coast in October 1978, has mistakenly convinced the MPCU that booms are useless. But MPCU's present strategy—to spray oil that is threatening beaches or wildlife sanctuaries but to do nothing else—excludes other options such as using new techniques and more effective skimming equipment.

For example, BP is trying out new methods of operating booms—such as allowing them to move with tidal currents while using advanced skimmers to lift the oil within them into storage tankers. These methods, says Harper, would be much more effective than the present policy of "do nothing or spray".

If Britain were faced with a spill such as the one now happening off the French coast (where the Tanio, carrying 26 000 tonnes of very heavy fuel oil, split in two last Friday) the MPCU would be powerless if it relied solely on spraying. This is because the dispersants MPCU holds in stock do not work on heavy fuel oil—as the Eleni V incident in the North Sea clearly demonstrated. But used properly, booms and skimmers could minimise the amount of oil that reached the shore, Harper says.

Although the MPCU has been in existence for more than a year, it has not given a lead to the handful of small companies that are building and developing equipment for controlling spills Harper claims. His company and four others have set up a "flying squad" to fight spills.

Captain John Walters of BP Petroleum Developments supported Harper's criticism of MPCU. Walters told *New Scientist* that, compared with equivalent organisations in the US, Sweden, Norway and France, the MPCU "looks pretty pitiful". Its operations, he said, are too *ad hoc* to be effective. ☐

Europe turns its gaze to the stars

Europe's next big space science project will be a satellite that measures accurately the positions and motions of 100 000 stars. The European Space Agency's Science Programme Committee chose the project from a number it considered at a meeting in Paris last week.

The mission, which goes under the name of Hipparcos, will provide information that is "relevant to many fundamental problems in astronomy and will lead to a better understanding of the Universe," says ESA. Using a telescope that can simultaneously view two areas of sky separated by large angles, the satellite will measure the angles between thousands of pairs of stars over a period of 2½ years, after launch by ESA's Ariane rocket some time in 1986.

It will take a team of scientists another 10 years to transform the data from the satellite into a catalogue of valuable information on 100 000 stars. The data are vital for astronomers who want to determine the distances and luminosities of stars, which in turn are important factors in theories of the evolution of stars, our Galaxy and the Universe.

Another project that ESA has not ruled out entirely is to send a probe to fly close to Halley's comet during its return in 1986. The Science Programme Committee has instructed the ESA Executive to continue studying the possibilities of such a mission, particularly exploring the possibilities of cooperation with the American space agency, NASA. A previous scheme for a joint mission between ESA and NASA, involving a fly-by of Halley's comet and a longer-term "rendezvous" with the comet Tempel-2, died earlier this year when President Carter presented NASA's budget request for 1981 to Congress. The budget made no provision for the solar electric propulsion system necessary for the rendezvous with Tempel-2. However, both agencies could still go ahead with a fly-by of Halley's comet as a part of the Hipparcos mission, although this would mean stretching the timescale of the mission. ☐

The Tanio broke in two last week in a storm off the coast of Brittany. Britain's stocks of dispersant would be useless against the kind of heavy oil the Tanio spilt

Popperfoto

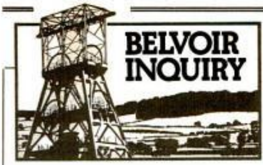
A surcharge for short-term researchers

Research grants to universities in Britain could carry a "surcharge" to help short-term researchers, if a scheme the Association of University Teachers (AUT) is currently negotiating is widely accepted. The AUT is trying to persuade a university, which it refuses to name until its negotiations are complete, to refuse research grants unless the grants include a 20 per cent surcharge. The extra cash would go into a fund to provide severance pay for short-term researchers in the university whose contracts come to an end.

The university in question has agreed to the scheme in principle, but is withholding final approval until the funding bodies it deals with have agreed to cooperate. Next week, the AUT will ask the research councils to consider adopting the idea on a wider scale.

The AUT has also approached the Department of Employment in a bid to prevent changes in the Employment Protection Act which parliament is now considering. Currently the act prevents universities offering short-term contracts containing "waiver clauses" if the contracts are for less than two years. Waiver clauses remove an employee's right to redundancy payments and to appeal to an industrial tribunal against wrongful dismissal. The amendments parliament is now considering would reduce the minimum term for a contract with waiver clauses to one year.

Many short-term researchers object to the loss of rights that waiver clauses involve and any reduction in the minimum term of their contracts would make matters worse for them. John Akker of the AUT says that Department of Employment officials were surprised to find out that many short-term researchers effectively do the same job for long periods, even if they have several contracts, one after the other. He says that the department's attitude to the plight that short-term researchers find themselves in is "sympathetic". ☐



Farmers fire warning salvo

Roger Milne

The National Coal Board can expect little comfort from the inquiry until after the Easter break, now that the farmers, residents and parish councils from in and around the Vale of Belvoir hold the floor. Last Thursday was day 61 of the proceedings and it saw Peter Boydell, QC open the case for the Alliance—the umbrella group of local objectors. There were plenty of Alliance supporters present to hear Boydell fire the first salvo, more a warning shot across the NCB's bows at this stage than any concerted bombardment. The Alliance's "big guns" come later.

Not since the beginning of the inquiry has the assembly hall at Stoke Rochford been so packed. There has been a sudden rash of new badges worn sportingly in tweedy lapels proclaiming "I'll lie down with the Duke"—a reference to the Duke of Rutland's now famous threat to block the path of the first bulldozer to move into the Vale, should the NCB's Vale of Belvoir project go ahead.

The Duke's family home, Belvoir Castle, is one of the tourist attractions that objectors believe will be adversely affected if mining comes. The castle receives 85 000 visitors a year while the Vale clocks up some 250 000 tourists and day-trippers annually. An NCB offer to leave a pillar of coal totalling some 1 750 000 million tonnes under the grade-one listed castle to prevent subsidence doesn't seem to have won the board fresh converts.

Whether the NCB should be taking heart from the fact the Alliance is apparently modifying its opposition is a moot point, though. Boydell said the Alliance was not claiming that mining should never take place. Rather coal "should be won by methods which are compatible with the retention of the Vale in its rural and agricultural condition. Sir, it is as certain as anything can be in this uncertain world that there will be technological advances of such a kind as to enable this coal to be won by methods which are compatible with the retention of the Vale as a stretch of beautiful country and as productive farmland."

Pete Addis

Boydell told the inspector, Michael Mann QC, that he should recommend against the NCB's £760 million scheme because "the refusal of the permissions sought here might itself act as a spur to the development of technological improvements". And reciting—though sadly not singing—from the 19th century popular ballad *Clementine*, Boydell went on to say that if the mining comes about "it would be the Vale of Belvoir which would be 'lost and gone for ever' and it would be the Secretary of State who would be 'dreadful sorry' that he had brought it about".

One of the brighter spots in a bleak week for the board was a statement from the Central Electricity Generating Board announcing its continuing support for the development of the north-east Leicestershire coalfield. □

A great LEP forward

A new £300 million accelerator for particle physics "should be built as soon as possible", according to delegates at the Committee of Council for CERN, the European Organisation for Nuclear Research. The new machine, in which physicists would collide beams of high-energy electrons and positrons, will be the responsibility of a new director of CERN. Last week, CERN's Committee of Council unanimously supported the appointment of Professor Herwig Schopper as director from 1 January, 1981. Schopper is currently director of DESY, the German national accelerator laboratory at Hamburg.

Europe's new large electron-positron machine (LEP), proposed for CERN's site at Geneva, would consist of an accelerator ring 30 kilometres in circumference in which oppositely directed beams of electrons and positrons would be stored, accelerated and collided. In the head-on collisions between the two beams, each of energy up to 90 giga electron volts (about 90 times the energy equivalent to the proton's mass), physicists hope to create particles called the W^+, W^- and Z^0. These are the particles that theorists believe "carry" the weak nuclear force between interacting particles in processes such as the radioactive beta-decay of neutrons.

These intermediate particles will appear only at the high energies in a machine such as LEP because they are too heavy to be produced in existing accelerators. The particles must be heavy to explain why the weak force is weak, acting only over distances comparable to the size of a nucleus (10^{-15} m)—you cannot throw heavy things very far.

The proponents of LEP believe that it can be financed from the existing CERN budget, to which the UK currently contributes nearly 16 per cent. However, CERN would have to shut down several existing facilities to "free" the money for LEP.

Physicists working at CERN are generally pleased with the choice of the new director. At DESY, Schopper was the brains behind a world-beating accelerator called PETRA. This is a smaller version of LEP, taking beams of electrons and positrons to about 30 GeV each. PETRA has given European physicists a year's lead over their American colleagues, who eagerly anticipate the start-up of a similar accelerator at Stanford later this month. □

Whats in a name?

As expected, the "scientific" part of the Hamburg Scientific Forum of the Conference on Security and Cooperation in Europe (CSCE) was a disappointment. Indeed, had it not been for the recent moves against dissident scientists in the USSR, the whole fortnight of the forum would have been an unremarkable event. As it was the treatment of Andrei Sakharov in particular goaded the leaders of the West's science establishment into action and, among others, the president of the Royal Society, Lord Todd, finally came out with a public statement of discontent at Soviet behaviour that some of his colleagues have expected for some time now.

There was a half-hearted effort to persuade the Western side of this East-West dialogue—the Hamburg meeting arose out of the Helsinki agreement on human rights—to boycott the forum. This move came to nothing, partly because of fears that if nobody turned up from the West the USSR and its satellites would use the forum's imprimatur to put out an anodyne statement. As it turned out, there was a long battle at Hamburg to find a set of words that would convey Western discontent at the treatment of dissidents in East Europe without offending the Russians. In the end the conference came up with "equitable opportunity", for "freedom".

The conference report calls for improvements in international cooperation in research and training and in exchange of information. This cooperation should be achieved "bilaterally and multilaterally at the governmental and non-governmental levels through inter-governmental and other agreements, international programmes and cooperative projects, and by providing equitable opportunities for scientific research and for wider communication and travel necessary for professional purposes". One of Lord Todd's criticisms of the Soviet Union is that it denies all but a few scientists freedom to visit the West. □

Aiding the Third World's environment

The US Agency for International Development (AID) has failed to implement properly its environmental policy, according to a report from the US Natural Resources Defense Council. The report generally commends AID's procedures for environmental impact assessment. But after visiting aid missions in Mali, Liberia, Bolivia, Peru and Indonesia, the NRDC concludes that AID has not got the technical staff to back up its environmental policies.

The report is one of a series examining the environmental policies of six bilateral aid agencies in Canada, the Federal Republic of Germany, the Netherlands, Sweden, Britain and the United States. The International Institute for Environmental and Development (IIED) is preparing the studies with money from AID, among other agencies. IIED asked NRDC to carry out the first study—of AID itself.

In 1977 the US Congress gave AID its first mandate to add "environmental and natural resources" to the list of development problems AID tackles, although the agency had issued an environmental policy statement promising to study the impacts of its own projects as long ago as 1975 (in response to a lawsuit brought against the agency by environmental organisations). And in 1978 Congress confirmed AID's obligation to consider the environmental impact of its own projects and to identify the major environmental problems in each aid-receiving country. Congress particularly stressed that AID should tackle the problem of deforestation and soil erosion as part of its programme for "agriculture, nutrition and rural development", which had $609 million to spend last year.

AID is revising its procedures for carrying out this mandate. Currently, these consist of an initial environmental examination prepared at the same time as the short document proposing a new project idea sent in by the aid missions to Washington headquarters. Here, officials decide whether the likely environmental impact of the project demands a full-scale environmental assessment. These must be completed before AID approves a project, often within as short a time as six weeks.

The NRDC report notes that AID contracts out many of the environmental assessments to consultants with no experience in tropical environments. "In some cases, site visits have been so brief as to hardly be worth the effort."

But the biggest fault with the procedures is that they focus on the likely environmental hazards of the design stage of a project, and make little attempt to assess what might happen in the long term. The NRDC team points out that like most other aid agencies, AID is an organisation of planners and administrators, much more concerned with getting projects approved than with what happens later.

The report spells out clearly that changes are needed at the top. AID's leaders must decide to set aside enough money to hire technical people, perhaps retired engineers, who know how to recognise potential problems and then the agency must give them authority to remedy mistakes. AID should evaluate the environmental impact of projects after they are completed. The report calls for 14 more AID staff with environmental and natural resources experience, and for more training for other AID staff. Given that the current costs of preparing environmental reviews can be as much as $90 000 for a major irrigation project, the follow up is particularly important. □

Farmworkers attack pesticide safety

This week the farmworkers' union submitted a dossier repeating its call for a ban on the pesticide 2,4,5-T to Peter Walker, Minister of Agriculture. Walker has agreed to pass the document to his Pesticides Advisory Committee (PAC), which the union criticises severely for failing to take 2,4,5-T off the market.

The National Union of Agricultural and Allied Workers (NUAAW) has collected several case histories of people suffering from diseases the union believes 2,4,5-T might have caused. Much of this evidence—such as a lady from Gwynned who had a miscarriage after eating blackberries from an area the Forestry Commission had sprayed with 2,4,5-T—is anecdotal. But this lack of scientific data is, in itself, a criticism of the way the government regulates pesticides: there is no system for monitoring their effects.

The union does, however, point to considerable animal evidence (and to the results of some surveys of human health) in support of its contention that the dioxin contaminant in 2,4,5-T causes cancer, birth defects and miscarriages. It accuses the PAC of a "lack of scientific rigour" because of the conclusion of PAC's latest review of 2,4,5-T's safety—that the small amounts of dioxin in 2,4,5-T are not dangerous "provided that the product is used as directed". The union points out that conditions in the field often make it impossible to use the product as directed.

The NUAAW says it is "extremely concerned" about the Ministry of Agriculture, Fisheries and Food's system of controlling pesticides. It agrees with the criticism in the Royal Commission on Environmental Pollution's most recent report—namely that MAFF's promotion of agricultural productivity inevitably conflicts with its efforts to control pesticides. And the union points out that only academics and civil servants sit on PAC—the unions representing the people at risk have no voice. □

Two US studies weaken saccharin-cancer link

Whatever saccharin does to rats, it does not after all appear to cause bladder cancer in humans, according to two separate studies published in the US this week. Both reports compare past saccharin use among people known to have bladder cancer with that of similar people who are healthy—and the difference is negligible.

One study, by Dr Alan S. Morrison and his colleagues at the Harvard School of Public Health and reported in the *New England Journal of Medicine* (vol 302, p 538), involved 592 adults with cancer of the lower urinary tract and 536 controls. It showed that people who had taken saccharin regularly for as long as 10 years had at most a 10 per cent greater risk of bladder cancer than nonusers, and this risk did not appear to increase with heavier use of the artificial sweetener.

The other report, published in *Science* (vol 207, p 1214), comes from epidemiologists at the American Health Foundation in New York City. They found no increase whatever in the risk of bladder cancer among 367 users of saccharin compared with an equal number of nonusers. In fact, they reversed their previous report of increased cancer risk among people who use saccharin. That result was an artefact, they now say, caused by differences in social class between cancer patients and controls.

But neither research team gives saccharin a totally clean bill of health, despite these findings. Saccharin may be like other carcinogens that cause bladder cancer after a lag of 40 or 50 years, the Harvard team notes, and "more consistently positive results" may appear.

An editorial in the *New England Journal of Medicine* accompanying the Harvard study concludes that the use of saccharin by pregnant women and nondiabetic children "should be actively discouraged". Dr Ernest Wynder, president of the American Health Foundation and head of its saccharin study, agrees. "We cannot say anything about pregnant women or children, because we did not study them," he says.

This is one reason why Dr Anthony B. Miller, who led an early study linking saccharin with cancer, thinks the sweetener should not be slipped into food without the public's knowledge, which is what happens in Britain. Miller, who is British, prefers the legislation in Canada (where he now works at the National Cancer Institute). There, saccharin is available in tablet form from chemists but is not added to manufactured food.

Miller feels saccharin probably is a carcinogen in high doses and in the presence of other cancer-causing agents. "The situation in the UK worries me greatly," he says. "There is a feeling that saccharin is perfectly safe for humans—and there are signs that it could become a widely distributed carcinogen." □

France in a fuel's paradise

The French are finding that reprocessing nuclear fuel is not as easy as they once thought. Last week, Cogema, the state-owned French nuclear fuel company, admitted that its plant at La Hague is handling only half the amount of spent fuel from light water reactors that was planned originally.

The section of the La Hague plant that reprocesses highly radioactive oxide fuel should take 400 tonnes of spent fuel a year. But unforeseen hitches will restrict the plant's capacity to 250 tonnes a year until 1983. The problems are minor but troublesome—Cogema says there is no major defect in the plant's design. For example, Cogema finds it more difficult than expected to recover bits of sheared fuel containers that fall into pools storing radioactive material.

Cogema says its first priority is to reprocess stockpiles of spent fuel from France's gas-graphite reactors. Some of this fuel has been in storage pools for years and its casing has deteriorated. Reprocessing the stockpiles, however, should be straightforward—La Hague can handle 800 tonnes a year.

The problems arise when the French reprocess fuel imported from Japan, West Germany, Belgium and Switzerland. Cogema reprocessed 69 tonnes of this high-activity oxide fuel in 1979 (as well as two tonnes of spent fuel from the French Phenix fast breeder reactor). But it plans to reprocess more than 5000 tonnes of imported spent fuel in the next decade, as well as 2000 tonnes of spent fuel from French light water reactors by 1985. Cogema will have to expand its La Hague plant to take the fuel. In the meantime, the company will store the material in pools. One of these pools will be ready by 1981. *Andrew Lloyd, Paris*

Marmot misfortunes

Big business and conservation seldom go hand in hand. But there are exceptions and MacMillan Bloedel, a giant Canadian logging company, seems to be one. The company has offered to swop a tract of land where the threatened Vancouver Island marmot lives for a similar plot of the same size or value provided by the provincial government of British Columbia. The company suggests that the plot it offers to exchange should become an ecological reserve.

New lease of life for the marmot

The Vancouver Island marmot is unique because it is a species in itself, *Marmota vancouverensis*. There are only 50 to 100 marmots of this species left on Vancouver Island. They live in small, isolated colonies that contain no more than a dozen animals. Because the colonies are so scattered, the marmots do not interbreed, weakening the species' ability to survive. Disease or fire could devastate a colony.

The marmots live in windswept rocky outcrops in alpine meadows. Forests below used to protect the marmot against human interference. But logging opened up the timber and with the clearings came the rough roads that enticed hunters, hikers and skiers. Distressingly for marmots, the latter pack down the snow over the animals' burrows.

Margaret Evans, Vancouver

Uranium down under

The Australian government last week moved one step closer to committing itself to establishing a uranium enrichment plant. Trade and Resources Minister Doug Anthony, in presenting an Australian Uranium Advisory Council (UAC) report to parliament, used the occasion to express support for the idea of an enrichment plant.

The council does not, it seems, share some people's doubts that the Australian Atomic Energy Commission (AAEC) has the necessary technical skills and experience to advise on—or take part in—the building of an enrichment plant. But the UAC expressed no opinion about the economic viability of a plant to exploit Australia's huge deposits of uranium, the second biggest in the world. The AAEC is investigating the gas centrifuge technique for enrichment—the method the UAC favours.

This preference for the gas centrifuge technique should encourage URENCO the uranium enrichment organisation run by Britain, West Germany and the Netherlands, but can hardly please French nuclear engineers who have tried to interest the Australians in their gaseous diffusion technology.

Brian Lee, Canberra

School computers

London could soon have a special education centre devoted solely to encouraging the use of computers in the capital's schools and colleges. The centre would be in a disused school building in Southwark, south London, and would cost £300 000 a year to run. Its staff would travel round the city's schools, helping teachers to develop software and advising them how to assimilate computer techniques into ordinary lessons on, say, mathematics or geography.

Members of the Inner London Education Authority will discuss details of the plan shortly. According to Derek Esterson, the authority's staff inspector with responsibility for computing: "There is an essential need for such a facility. Schools cannot be expected to cope without it." About half the 175 secondary schools in inner London, and 17 of the 40 or so further education colleges, already have their own microcomputers. But, Esterson says, many of them lack the experience to use the machines properly.

Some of the money for the centre could come from the £9 million that the Department of Education and Science (DES) has made available to schools and colleges over the next four years to help them to develop applications in microelectronics. Originally, the DES planned to give £12·5 million over a five year period. □

THE NEW SCIENTIST
20 years ago

Journalists who attend press conferences regularly have sometimes suspected that there are certain little-known laws which accompany the hospitality that often accompanies them. One is that the number of column-inches of editorial matter expected varies directly with the number of square inches of smoked salmon consumed. Another, better-founded one, is that the quantity of refreshment provided is in inverse proportion to the news value of the subject of the press conference.

The New Scientist, 17 March 1960

Schumacher centre

Shirley Williams heads the list of luminaries sponsoring an appeal launched last week for £1 million to set up a new Schumacher Centre for Technology Choice. The sponsors hope the centre, in London, will spur development of small innovative enterprises in the depressed parts of Britain—in northern England, Scotland and in Wales.

The Intermediate Technology Development Group (ITDG) is launching the appeal. ITDG was set up in 1965 by E. F. Schumacher, populariser of the idea of "appropriate" small-scale technology. The early focus of ITDG was on the Third World but in 1975, against the background of unemployment in industrialised nations, Schumacher set up an appropriate technology unit for Britain. The new centre in London will include a special unit to work in closer association with existing local enterprise trusts and develop new ones, generally acting as broker giving credibility to small firms seeking finance to expand from all too sceptical institutions.

ITDG expects that it will cost £500 000 to buy and convert an old school or warehouse large enough to house an information unit, services for local entrepreneurs — such as telex facilities — a canteen, office space and a "working community area". The centre would also provide a new home for the ITDG. The remaining £500 000 would be invested, and the interest would pay the salary of the small staff of the new centre consisting of director, secretary and information officer. □

Who are the computer criminals?

If you look at the cases with care, you will find that the common image of a computer criminal is not justified by the facts

Jay Becker
is director of the
National Center for
Computer Crime Data
in Los Angeles

The fashion, for journalists and criminologists, is to see all computer criminals as geniuses. Donn Parker, in his book *Crime by Computer*, reflects this when he writes: "Perpetrators are usually bright, eager, highly motivated, courageous, adventuresome, and qualified people willing to accept a technical challenge. They have exactly the characteristics that make them highly desirable employees in data processing." F. W. Dennis, writing in *Security World* in September 1979, paints the same picture: "The common denominator in nearly all cases of computer fraud has been that the individual is very much like the mountain climber—he or she must beat the system because it is there."

But is the picture accurate? Does it help us to prevent computer crime? Based on my analysis of many of the cases in the files of the National Center for Computer Crime Data, I must answer both questions with a resounding "No".

Many computer criminals just aren't that clever. Their crimes are not that technically sophisticated. And even if it were true, this view of computer crime wouldn't be very helpful. No test has been devised to separate computer geniuses who are prone to crime from law abiding computer geniuses. Lacking this type of test, it wouldn't make much sense to ask a personnel director to screen out all geniuses lest they commit computer crime.

As the criminal sees it

Environment, not personality, seems the most useful factor in predicting computer crime and preventing it. The data suggest that certain "criminogenic environments" are present in most computer crimes. By criminogenic environments I mean the computer system, *as the criminal perceives it*, immediately before he or she decides to commit a computer crime. For example, one type of computer criminal will see the computer environment as a cookie jar—the source of enough money to meet sudden needs. Another may see it as a playpen—simply a place to play computer games as long as he or she likes. These different perceptions, and the attitudes they reflect, will generally lead to very different types of computer crimes, and require different types of security to prevent them.

In this article, I shall suggest seven views of the computer system which seem to summarise most of the cases that I have seen.

● **The playpen** The American educational television network recently broadcast a one-hour show about computers as tools in the education of nine and ten year olds. About the only discordant note in this paean was one teacher's observation that her students kept erasing each other's names from computer sign-up lists, or destroying the sign-up lists altogether. The teacher tolerated this aberrant behaviour, apparently delighted that her students enjoyed playing at the computer.

Older students have the same morality. Professor John Carroll found that 34 per cent of the students in two courses on advanced information systems at the University of Western Ontario had tried to obtain computer time without paying for it. The same percentage had tried to penetrate the computer's security system.

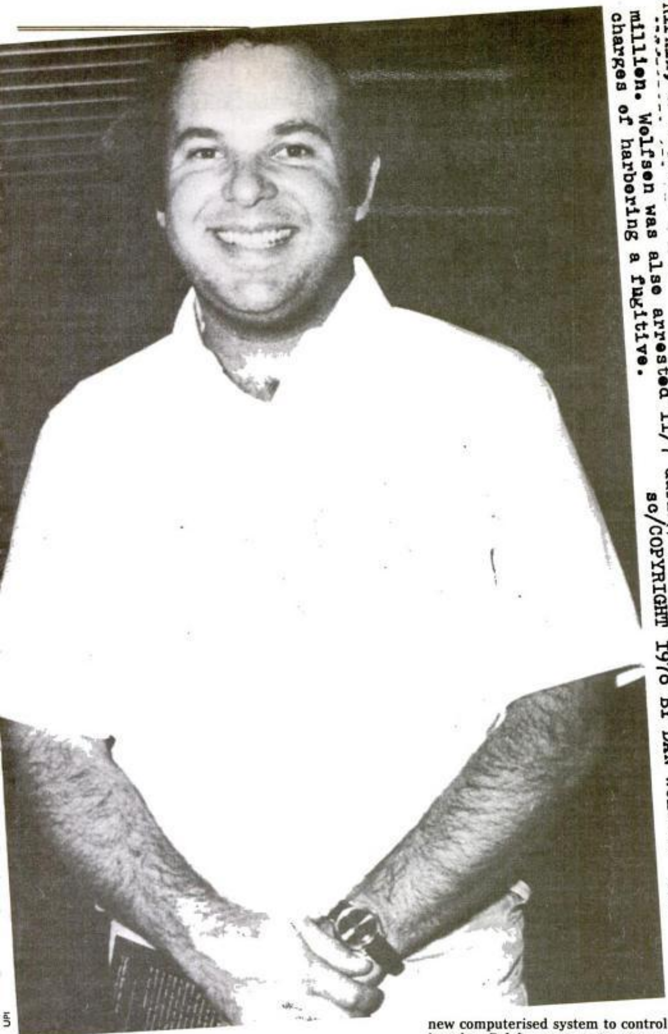
These examples demonstrate the fact, obvious to anyone who has watched people play computer games, that simply using a computer can be intrinsically satisfying. They also suggest that the drive for this satisfaction can violate others' rights. When computer crime results from the attempt to gain satisfaction from working with the computer, I categorise it as an example of the playpen perception getting out of hand. Unfortunately, there is no standard within the computer industry to define precisely *when* the playing has got out of hand. Thus, if a student uses an hour of computer time without permission, one university computer department considers it criminal theft of services and another views it as commendable ingenuity.

In addition to the unauthorised use of time (and often as a necessary prerequisite to it) attempts to compromise computer security systems are common to those with a playpen point of view. An English group calling itself Crank boasts of expertise in "computer piracy and security cracking". Members of Crank claim to have obtained files from universities and companies in England, including one whose security "has never been broken", all with the ostensible purpose of making sure that computer security is improved. But it would take only a small change in the motivation of Crank members to wind up with someone who seeks to outsmart the computer for his or her own benefit.

This may have been the dominant motivation behind Stanley Rifkin's infamous computer crime. When Rifkin pleaded guilty to charges arising from his theft of £5·1 million from an American bank, he described his reaction to what he had done. "I was aghast," he said, explaining that his arrest was the first indication he had had that his scheme really worked. He further explained his failure to hide the diamonds he had bought with the stolen funds, saying he hadn't made any plans for this contingency. Implausible as this story may seem, it is consistent with Rifkin's general ineptitude as a thief and his rapid arrest once he returned to America. Further support for the idea that Rifkin had a playpen perspective comes from an associate who once taught with Rifkin. "The guy is not a bank robber, he's a problem-solver," was Professor Gerald Smith's opinion.

In view of what I have already said about the playpen attitude towards computer environments, certain security implications immediately become evident. Norms that clearly define allowable and excessive computer use will develop, and if the industry does not develop them, it's quite likely that the law will. In the meantime, each computer user must evaluate its rules and practices. Unless these clearly communicate the limits on unauthorised computer use, and the rationale for these limits, the user will continue to be vulnerable to the computer "game player" who goes too far.

● **The land of opportunity** Not too far removed from the playpen perspective is the attitude that there's nothing much wrong with exploiting an obvious vulnerability in a computer system. Unlike the game players in their playpen, those who see the computer environment as a "land of opportunity" seem to be motivated not so much by challenge as by lack of challenge. Where the game player might try hundreds of codes to find one which gives entry to the computer's operating system, the employee in the "land of opportunity" just finds and exploits a vulnerability in the system—often in the course of learning his or her job. For example, the operator of a device for printing cheques pressed the REPEAT button again and again when his own cheque was being produced. Hardly the computer genius the media would have us think all computer crimi-



NXP/KMP02II07-II/7-CARLSBAD,CALIF: Stanely Mark Rifkin, 32, smiles in this picture
taken minutes after his arrest by FBI agents in an apartment here near San Diego II/6.
The photo was taken by Dan Wolfsen,who rented the apartment where Rifkin was arrested.
Rifkin, a computer wizard, is charged with defrauding a Los Angeles bank of $IO.2
million. Wolfsen was also arrested II/7 during a telephone interview with UPI and faces ju
charges of harboring a fugitive.
sc/COPYRIGHT I978 BY DAN WOLFSON via UPI

UPI

nals are, he took a dozen cheques and attempted to cash them all at the same time. More sophisticated, but similarly opportunist, Jack Polak exploited his position as a purchasing agent in the county of San Diego, California. Knowing the troubles the county was having in installing a new computerised system to control its payments for goods bought, Polak set out to compromise the system. He created fictitious vendors, charged the county for non-existent supplies that had ostensibly been delivered, and collected approximately £25 000 in payments. He knew the county's system too well. Only his impatient questioning about a £35 000 cheque he awaited led to his detection.

UPI

Part of Stanley Rifkin's £5 million haul of money and gems

One needn't be a profound criminologist to realise that motivation is directly proportional to opportunity, and opportunity is inversely proportional to the security of a system. If the opportunities are obvious enough, even the least sophisticated employees (or outsiders, for that matter) may be expected to try to exploit them. Consequently, the need for systematic and extensive security cannot be underestimated. Simple measures—such as taking particular care of employees' accounts which are under the computer's control, rotating personnel from job to job, and looking for any trends of irregular work habits which might either give rise to or explain computer crime, are just some of the measures that a company might take to reduce its vulnerability to those who see the computer as a land of opportunity.

● **The cookie jar** A gambling debt, a drug habit, sudden losses on the stock market, may all lead an employee to see the funds in a computer as the best solution to his problem of the moment. As though it were a cookie jar, the "hungry" criminal dips into the computer to take what he needs. In such circumstances, the criminal's motivation is much more pressing that his observation of a loophole in the system is security. Criminologists have identified such "situational pressures" as frequent accompaniments to white collar crime in general; as computer crime is a subclass of white collar crime, I am not surprised that these pressures operate here as well. Case histories of computer crimes bear me out.

One head teller at a bank in New York City was found to have stolen £750 000 when his bookie was raided and it turned out that he was betting up to £15 000 a day. And in Denver, Colorado, Raymond Ressin financed numerous gambling trips to Las Vegas by falsifying the input to the computer of the stock brokers for whom he worked.

To counteract people whose need drives them to cookie jar crimes, companies must investigate employees before they are hired. But situations change, and security must be responsive to these changes. Ideally, the relationship between employees and their supervisors and management in general will be such that the employee will seek out help when a problem arises.

● **The war zone** Some people see the computer not as a solution to life's problems, but as a symbol of their cause. Disgruntled employees, who feel that management is out to get them or that they have already been hurt unfairly, may express their resentment in attacks on the company computer. This type of employee sees the computer as a "war zone", the battlefield in the struggle between employer and employee.

In Sacramento, California, three employees of the State Department of Justice, apparently annoyed by the paltry amount of their pay increase, deleted certain arrest records from the State's criminal records. There are numerous other tales of computer library tapes erased, misfiled, or mislabelled, or instructions to erase all company records two years after a certain programmer is fired. Employees have even literally attacked the computer with sharp instruments, screwdrivers, and guns.

In one of the most extreme cases I know of, an employee of a large produce company, feeling cheated out of a substantial pay rise, created a "shadow corporation" for revenge. The shadow was almost exactly like the real corporation, except that it was about 0·75 per cent less efficient—more vulnerable to theft, spoilage, and so forth. All of the financial differential between the shadow corporation and the real corporation went into the pockets of the disenchanted employee.

As in the case of the "cookie jar," good management is the best prevention. Where are are no acceptable avenues to express resentment toward the employer, management should not be surprised when unacceptable avenues are used instead. There is also the possibility that the employee's resentments are well-founded. Corrective action will not only reduce the threat of the resentful employee, but also demonstrate to all employees the folly of perceiving the computer as a war zone.

● **The soapbox** In the war zone, the criminal gets at the employer through the employer's computer. The soapbox computer criminals find computers themselves anathema, and see computer crime as a way to strike out *against the computer*. Thus, they see a war going on, not between the employer and themselves, but between themselves and any one of a number of different forces.

In some cases, the slogan of the 1960s—I am a human being; do not fold, staple, or mutilate me—has been converted into an unreasonable dislike for the computer itself. In one case, a programmer sabotaged a computer by short-circuiting the computer's memory. He told the police that he had an "over-powering urge" to shut the computer down, and had no grievance against the owners of the machine.

Terrorist bombings reflect a much more extensively developed symbolism. In Italy, the Red Brigades produced a telling document, *Resolutions of the Strategic Directorate* that depicts increasing computerisation in Western countries as part of a sinister plot to "maximise social controls". The *Resolutions* explain that because computers are instruments for the "repression of the class struggle . . . it is important to attack, unravel, and dismember these networks of control".

Where the computer symbolises personal frustrations, the security measures to deal with the problem are not much different from those called for in the war zone. But soapbox crimes are as likely to be committed by nonemployees as by dissidents within. These sorts of attacks on the computer emphasise the need for attention to physical security. The common practice of making the computer centre the highlight of a public relations tour is thus a questionable risk, and companies should ensure that they stay aware of the activities of terrorists.

● **The fairyland** If any category of computer criminal completely belies the major myth, it is this one. Some of the participants in computer crime appear to act as though the computer environment were totally divorced from reality. A telex operator may routinely transfer millions of dollars from bank to bank without recognising how important each transaction is. The computer simply isn't real.

In *Computer Capers*, Thomas Whiteside tells of a fraudulent transfer of £1 million. The culprit convinced his girlfriend to transfer this amount to his bank in New York, telling her he wanted to play a joke on a computer-operator friend who worked at that bank. The friend and the money disappeared before the girlfriend realised that she had been conned as well as jilted.

Although it is perhaps dangerous to take assertions of ignorance at face value, the message behind cases such as this is quite clear. Where people associated with computer systems are unaware of their own power, and act as though there were no dangers of computer crime, the company who employs them is exposed to an enormous risk. Just as management cannot afford to ignore the new vulnerabilities a computer creates in any business, so it cannot afford to have employees who are ignorant of these vulnerabilities. Clear communication of the responsibilities of the job, as well as clear standards for its performance are the most obvious management tools to combat this problem; the company should make it clear that each employee has a stake in computer security.

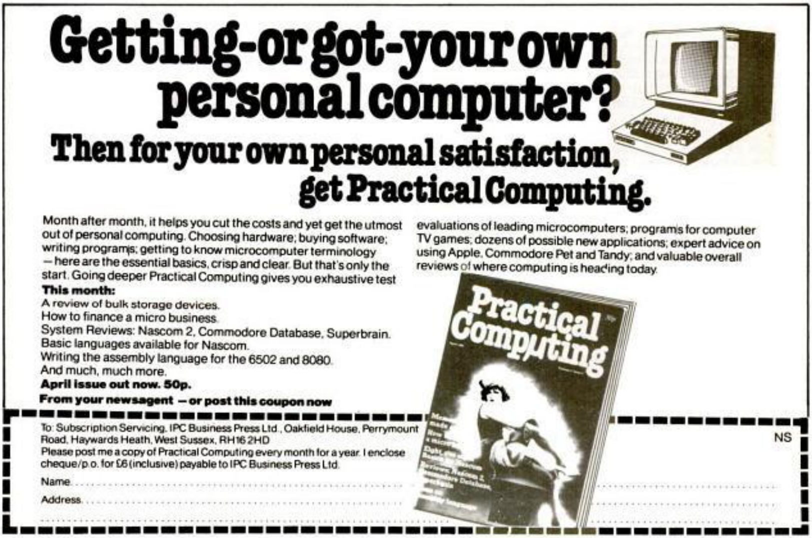
The other side of the fairyland mentality is that even if the employee's ignorance of computing does not facilitate a crime it may stand in the way of that employee detecting the early warning signals which, acted on promptly, might reduce crime. It is clear to me that one of the important security devices in a manual system is that lots of people see each piece of paper, and they can tell unusual entries just because they run counter to common sense. To some extent we lose this security advantage when systems are computerised—and no longer easily understood by many people. If we could only get the game fanatics to teach the residents of fairyland about computing, both might develop more realistic perceptions of the computer environment.

- **The toolbox** To some computer criminals, a computer is simply a computer. Thus, we have cases of so-called computer crime where the computer is not the target, but the implement in a crime that in no other way involves computing. The phone freaks, who use microprocessors to test phone circuits and develop strategies that enable them to use phones for free, exemplify this attitude towards computers. The Equity Funding personnel, who used computers to create false insurance policies by the thousands, seemed similarly clear-headed about what a computer can do. Perhaps the most ludicrous example is the Los Angeles brothel owner who used a minicomputer to keep track of his customers.

These examples suggest a type of computer criminal we can call the technological crook, who sees the computer as another tool in his kit. This type of person is more likely to already be a criminal than any of the individuals whose attitudes I described above. As the key to this sort of crime is computer *use*, all those strategies which limit access to the computer are important security. But none of these "limited access" security procedures will be at all effective against the owner of a micro- or minicomputer who has worked out a way to use the computer to commit crime.

What to do next

The categories listed here are not mutually exclusive, exhaustive, or chiselled in stone, and I encourage feedback—particularly as to attitudes I appear to have missed. Furthermore, the categories may not be much use when we want to predict whether a specific individual is likely to become a criminal (unless we can develop tests to discover if a "suspect" is abnormally likely to perceive the computer environment along the lines the categories suggest). Still, if the company sees the environment as a playpen, a cookie jar, or any of the other models I've discussed, it may be inferred that some would-be computer criminals will see it that way as well. I hope that the security measures I have outlined here will offer some strategies to change or prevent these potentially dangerous perceptions. ☐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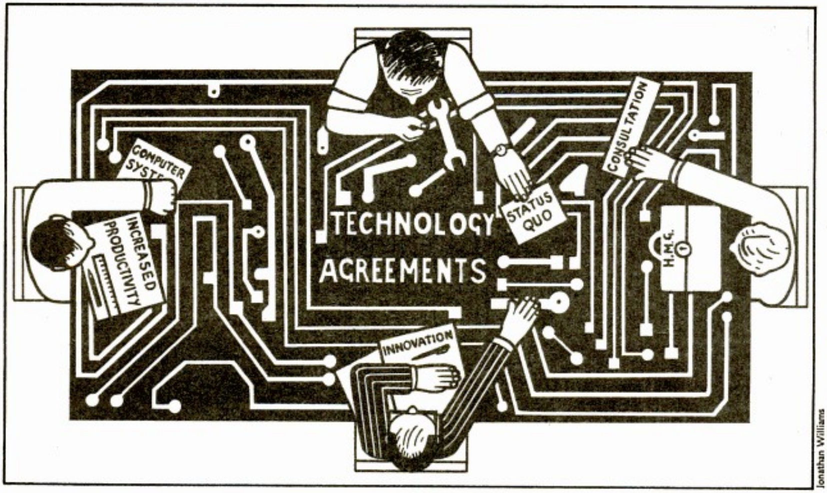

Jonathan Williams

In place of technological strife

All three sides of industry—government, unions and companies—believe that they can come to terms over the way that new technology is introduced. But before industrial peace is declared there are sure to be battles which will put computer technologists into the firing line

Malcolm Peltu

Margaret Thatcher should have no doubts that the phrase "technology agreements" will become as much a byword for the terminology of industrial relations in the 1980s as "closed shop" and "secondary pickets" did in the 1970s. At a recent meeting of the National Economic Development Council (NEDC) that she chaired (*New Scientist*, 17 January, p 143), government, management and unions agreed unanimously that technology agreements could provide a stable working environment in which innovation can be introduced without creating serious unrest. The Trades Union Congress and the Confederation of British Industry acted quickly and set up a joint study to determine mutually acceptable guidelines for such agreements. But early this year, the government also examined a proposal for a technology agreement from the civil service unions which indicates where the technology *dis*agreements are likely to occur.

The basis for the NEDC discussion was a ten-point plan that the TUC produced last year in its report *Employment and Technology**. The government and the CBI have agreed that these 10 points (see Box) could be a good starting point for developing guidelines for technology agreements, provided they are extended to emphasise the opportunities of using technology to increase productivity and competitiveness, and to stimulate the growth of small businesses.

A Department of Employment study† has since identified five key elements which, it says, offer "considerable scope for agreement" and in a report to its members, the Civil and Public Services Association (CPSA) has summarised the objectives of all the civil service unions. In some vital areas, the demands of the civil service unions are far more demanding than the department's list or even some of the TUC guidelines.

The two most controversial topics are the "status quo clause" (as it has become known in trade union jargon) and the request for "no job losses" rather than a "no-redundancy" agreement when a company introduces new technology. The status quo demand is summarised in the civil service's union's draft agreement by the statement that "new technology will not be introduced without the *prior* agreement of those unions with members affected" (my italics). This would mean a company planning to install "new technology" would have to have the unions' full agreement before any equipment was even selected.

The Department of Employment study†, *The Manpower Implications of Microelectronic Technology*, gives general support to the unions' request for more consultation and information before technology is introduced. "Management will decline at its peril" requests for such consultation, the study says. But it then points out that it will be difficult to "determine the precise point at which consultation should begin". Trade unions should accept that companies starting to use microelectronics in new ways will want to carry out some feasibility studies before they start formal consultation, the report asserts. "A realistic union aim might be to secure an agreement that consultation should begin before any options are foreclosed." To many trade

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* Report by the TUC General Council to the 1979 General Congress

† *The Manpower Implications of Microelectronic Technology*. HMSO, £3·50

TUC ten-point plan for technology agreements

- No new technology to be introduced unilaterally by management; status quo clause recommended—agreement before change; establishment of procedures for consultation.
- Inter-union collaboration in negotiations; build up of technical expertise by unions.
- Unions guaranteed access to information before decision taken.
- Aim to maintain and improve employment and living standards; no redundancies, or good redundancy payments; planned approach to redeployment and relocation of staff.
- Adequate provision for training and retraining; use redundancy period for retraining.
- Reduction of working hours and eventual elimination of systematic overtime.
- Avoid polarisation of workforce and disruption of existing pay structures; share benefits of technology among all employees.
- Unions should have a say in systems design and reprogramming; procedures established to cover personal data on workforce; no computer-gathered information to be used in work performance measurement.
- Stringent standards established on health and safety, particularly in use of visual display units.
- Joint union/management team to monitor developments and review progress.

Department of Employment's suggested guidelines to achieve "considerable agreement"

- Early and comprehensive consultation with full union access to information.
- Joint union bodies on employee side.
- New technology seen as providing opportunities for increased output and/or diversification.
- Job security, individual earnings and status guaranteed if possible.
- Appropriate training provided for job adaptation.

Objectives of civil service unions' draft technology agreement

- Prior agreement with unions before introduction of new machinery or work processes takes place.
- Full information prior to decisions about purchase of equipment.
- No overall loss of jobs.
- Immediate reduction in length of working week.
- Satisfactory arrangements for retraining, regrading and redeployment.
- Improvement in the quality of jobs.
- Rigorous health safeguards and safety controls.
- No loss of earnings, career opportunities and no deterioration in working conditions.

unionists, however, anything short of full "status quo" suggests that unions would be excluded from what they believe are the major decisions—whether and where technology is introduced—rather than just about the details of the system which the management has already decided to bring in.

On the question of job security, Jim Prior, Secretary of State for Employment, pointed out to the NEDC that while the TUC calls for "no-redundancy agreements" wherever possible, it accepts that, in some examples of innovation, redundancy is inevitable. But, he added, the department's study had found that few companies actually expected new technology to lead to redundancies, so managements are likely to agree to some form of job security. The civil service unions, however, are requesting that "new technology will not result in the reduction of the number of posts". The government's policy of cutting back the civil service is directly opposed to such an agreement and the unions claim to have seen documents which explicitly state that new or further "computerisation" is intended to save on staff costs.

Prior also highlighted an issue which poses an inter-union challenge. Most people accept that microelectronics and information technology could radically alter the nature of work and the skills needed to do jobs available. As he put it, to innovate successfully firms will wish "to be able to deploy skilled labour with much greater flexibility". In TUC terminology, this is expressed as the need to emphasise the "central role of collective bargaining" based on "joint union machinery" which should embrace "the largest possible proportion of the workforce since technological developments which initially affect only one work group may eventually have implications for the entire workforce".

Most union officials realise that the lack of inter-union working could be the main factor in slowing the drive for technology agreements. Union officials also admit that many local negotiators will accept technology agreements that fall far short of what the civil service unions aim for, but which satisfy the most pressing demands for their members. These will be to achieve no-redundancy or a guarantee of high redundancy money, to be able to participate in the introduction of the new technology, and to receive guarantees on health and safety in the working environment, for example when using computer terminals with visual display units (VDUs).

One senior union official recently told *New Scientist* that some trade unionists do not see the microchip as a technological end in itself. They do regard it as a means of providing a dramatic and practical way of sharpening negotiations which are really about a range of traditional industrial relations and political arguments, such as staff participation in the decision-making process, shorter working weeks and working life, the distribution of wealth, training and education, etc. The recent dispute at Times Newspapers showed with awful clarity how plans to introduce new technology can trigger off a damaging and bitter battle.

Isolated incidents like that at *The Times*, however, could become part of a growing worldwide concentration on technology agreements, backed by considerable research and analysis. It is still early days in the development of technology agreements. Norway made some pioneering agreements in 1977, but now British and international unions—

WE'RE ON A
THOMSON HOLIDAY
BUT NONE OF US ARE
GOING AWAY
THE NGA IS HERE TO STAY

Andrew Ward/Report

This is what happens when companies planning to install new technology don't reach agreement with the unions. In this case, Times Newspapers was closed for 11 months representing white collar, post and telecommunications, and metal workers—and the TUC have prepared detailed guidelines and draft agreements. In the US, the Ford Motor Company recently concluded a technology agreement with the United Automobile Workers which establishes a national committee to discuss technological innovation and which guarantees to give workers advanced warning of the introduction of new technology. A similar national agreement has been reached between the General and Municipal Workers Union and Imperial Tobacco in the UK.

Norwegian initiatives

Most guidelines for framing technology agreements follow two Norwegian initiatives—one is that the national trade unions and employers' federations should agree over general questions of staff participation in technological innovation. The second is a Working Environment Act which gives legal weight to efforts to promote a working environment in which new technology is introduced against a background of personal and social considerations, as well as business needs. The act, for example, specifies that "employees and their elected union representatives shall be kept informed about the systems employed for planning and effecting the work and about planned changes in such systems". This clause has been used to halt the introduction of technology if the unions feel there has been insufficient consultation.

The Norwegian union/management agreement introduced a concept which is also finding its way into other countries—to appoint a so-called "data steward", who acts as the union representative in the technical design. The TUC recognises that in many cases the need for expert data stewards is a strong argument for greater inter-union cooperation. In Norway, negotiations on industrial relations are far more centralised than in the UK; in some companies in Britain, more than half a dozen unions would be affected by a single technology agreement and there are often independent negotiations at different locations.

The concept of the data steward also highlights the need for computer scientists to take more responsibility for the human aspects of computer systems. In its proposals for technology agreements the international white collar union (which is generally known as FIET) explicitly states that unions should "challenge the attitudes of computer professionals and put the point of view of those affected by a system in their daily work".

Consultation with staff—and management—who will actually use computer systems should be an important stage of implementing and designing them. In the past, however, human participation in the design of computer systems has often been neglected, either by the omission of systems analysts and designers, or because systems were designed to satisfy a management's concept of the way its organisation operates, which is frequently different from the real world. A report in 1978 from the British Computer Society which examined the way computers met the needs of its users produced a catalogue of complaints against badly designed systems.

So, although there are important areas of dispute underlying official agreements on the desirability of technology agreements, if management and unions get together to talk about the way technology is implemented, the result could be better, more effective systems. And management might ask for a technology agreement with computer specialists which implements one rule in the Norwegian agreement that states "information on technology must be given to unions clearly and in a language easily understood by persons lacking special knowledge of the area". ☐

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Surfaces under scrutiny

Effects that occur at the boundaries between different materials, whether solid, liquid or gaseous, govern many aspects of our lives, but scientists are only now beginning to develop the techniques to study what goes on at surfaces

Dr Peter Dobson works in the Department of Physics at the Blackett Laboratory, Imperial College, London

Surfaces in one form or another influence our lives continuously. Life itself depends on processes that occur at "biological surfaces" in cells and across membranes, such as in the act of breathing (*New Scientist*, 7 February, p 408). Modern microelectronic devices—from the transistor to the ubiquitous "chip"—rely on the way electric charge behaves at the junctions between semiconductors and metals, and between different types of semiconductor. The chemical industry employs materials whose surfaces act as catalysts—substances that encourage a chemical reaction to take place, without actually taking part and being modified in the reaction.

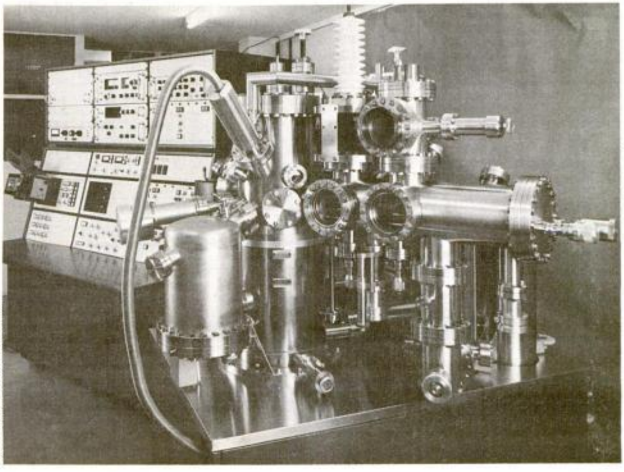
Despite the common occurrence of these and other examples, surfaces are difficult to study and to understand. Theories of how atoms behave *within* materials fail at the *edges* of samples, where the atoms are no longer completely surrounded by other atoms. And surfaces usually occur as *interfaces*, making it difficult to ensure that atoms in the surface layer do not interact with adjacent atoms, in the atmosphere above a surface, for example.

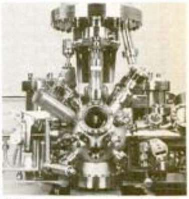
The science of surfaces is certainly not a new subject. Irving Langmuir, who received the Nobel prize for chemistry in 1932, for his work on the chemistry of surfaces, was a founding father of surface science. From 1909, working in the General Electric (US) Laboratories, primarily on electron emitters for radio valves, he laid the foundations for modern studies of clean surfaces. He pioneered work on layers consisting of single molecules and fostered an interdisciplinary approach to the study of surfaces. He also recognised that cooperation between engineers, physicists, chemists, metallurgists and biologists in these studies is essential as indeed it is today.

Surfaces have many different forms. A physicist might define a surface as the boundary between phases, such as solid-gas, solid-liquid, solid-solid, etc. This definition already highlights some of the difficulties a scientist faces in studying surfaces, in that the methods he can use for studying a solid-gas interface may be quite unworkable for a solid-liquid interface. Most of the major advances in surface science in the past 15 years have been in studies of the boundaries between solids and gases.

Several factors have contributed to these advances. First, scientists are curious about the physics and chemistry of "ideal" clean surfaces on perfect crystals. Secondly, advances in technology, particularly in the production of very good vacua, have made it possible to produce atomically clean surfaces—that is ones that are uncontaminated by "foreign" molecules. Thirdly, a host of analytical techniques has become available for the study of surfaces. Important technological implications in the chemical and electronics industries have added further impetus and incentive to researches in the field, and have extended the work from "ideal" clean surfaces to the "real" surfaces used in technology.

A surface scientist likes to begin by studying an "ideal", atomically clean surface. "Ideal" means that the atoms should be regularly arranged at the surface, or, in other words, the surface plane of a single crystal. It is relatively easy to cut a crystal to expose any desired crystal plane,





The multi-purpose analytical chamber (above) has facilities to determine the composition and structure of surfaces through a number of techniques. The apparatus shown left includes a scanning Auger microscope that can build up a map of the composition of a surface based on electrons emitted in the Auger effect, and is equipped so that samples can be fractured inside the vacuum chamber to expose clean surfaces

Photos by courtesy of V. G. Scientific

but it is not easy to avoid atomic disorder or contamination occurring during preparation. One problem is that atoms from the surrounding gas contaminate a surface, and that is why the technology for establishing an extremely good vacuum is essential for research on surfaces. Suppose for a moment that it is possible to prepare a clean crystal surface: how long will it be before it becomes covered with gas molecules? The kinetic theory of gases enables you to calculate the rate at which molecules of a gas bombard a surface, provided you know the temperature and pressure of the gas. Nitrogen molecules in a vacuum of 10^{-6} millibar (atmospheric pressure is about 1 bar) at room temperature bombard surfaces at rates such that if every molecule were to stick to the surface a complete layer of molecules would be deposited in two seconds, in a process called *adsorption*. So pressures of 10-100 thousand times lower than this are necessary if a *clean* surface is to be prepared and studied.

Researchers routinely obtain vacua of 10^{-10} mbar (known as ultra-high vacuum) in large stainless steel chambers which are easy to take apart and reassemble. Using samples within such chambers an experimenter can prepare atomically clean surfaces and study their properties as he contaminates them in a controlled manner, introducing whatever molecules he chooses. There are a number of ways of preparing such clean surfaces. The technique of ion bombardment uses a beam of argon ions, which are chemically unreactive, to knock off surface layers of atoms, whereas chemical techniques utilise oxidation and reduction cycles. Treatment at very high temperatures can be used to evaporate impurities from the surface, and it is also possible to literally split a crystal apart under vacuum, a process known as cleavage. The choice of preparation ultimately depends on the particular type of material being studied.

One area in which surface science is playing an increasingly important role, and in which I am involved, is that of catalysis—a basic phenomenon in the manufacture of many chemicals. Catalysis is often used to select a pathway via a particular chemical reaction, leading to the desired product, or a catalyst may make a chemical process more efficient by allowing it to take place at a lower temperature. A catalyst is a material that assists or activates a chemical reaction to give a particular product without irreversibly reacting with any of the constituents. For example nitrogen (N_2) and hydrogen (H_2) can combine to

A users' guide to techniques in surface science

Many techniques for the study of surfaces make use of low-energy electrons either as a probe—as with a beam of electrons—or through the production of electrons by beams of photons or ions. This is because electrons with energies in the range 10-1000 eV (one electron volt is the energy an electron acquires on acceleration by 1 volt) go an average distance before stopping—their "escape depth"—in solids that is very short, ranging between 0·3 and 3 nm (1 nm = 0·000000001 m). Electrons in this energy range can therefore penetrate, or originate from, atoms in only the outermost layers of a solid.

● LEED (Low energy electron diffraction) uses electrons of energy 20-1000 eV, in a beam perpendicular, or nearly so, to the surface. Measuring the angles between the diffracted beams gives the spacing between atoms in the surface plane, and the distance between adsorbed atoms and the surface plane, or between successive planes, can in principle be determined from the variation in intensity of the diffracted beams. But the latter is not an easy calculation and requires much computing. The technique has shown that the spacing between planes in the outer layers of the crystal surfaces in some metals is slightly smaller than the spacing in the bulk of the material. The distances from the surface plane of atoms in adsorbed molecules have been determined in a few cases, and it has been possible to demonstrate relatively complicated atomic reconstructions of the surfaces of some semiconductors. The technique is, however, restricted to the well-ordered surfaces of single crystals.

● RHEED (Reflection high energy electron diffraction) uses electrons with energy 5-40 keV, incident at small angles (0·5-4°) to the surface. The technique is potentially much more useful than LEED in that it is not restricted to the surfaces of single crystals and can give a higher precision. However, at present no theory exists that relates the spacing of atoms perpendicular to the surface to the intensity distribution in the diffraction patterns. The technique is particularly suitable for polycrystalline or amorphous (non-crystalline) surfaces, also revealing information about crystal defects in the surface region.

● AES (Auger electron spectroscopy). In the so-called Auger effect, excited atoms emit electrons with specific energies which are related to the binding energies of electrons in the atomic cores. The emitted electrons can therefore reveal the identity of atoms. Each atom in the periodic table has its own characteristic set of Auger energies, and those electrons with an energy less than 1000 eV have an escape depth of less than 2 nm; in other words those that do escape the sample originate in its outermost layers and permit an analysis of the composition of the surface. The technique reveals layers as thin as one-hundredth the thickness of a layer of atoms. The Auger electrons are excited with an electron beam with an energy of 2-3 keV.

● XPS (X-ray photoelectron spectroscopy) is used for chemical analysis of surfaces. Photons from "soft", or low-energy X-ray sources bombard the surface, causing it to emit electrons from energy levels within atomic cores. The energy and number of these electrons determines the composition of a surface. The fact that the kinetic energy of the emitted electrons is less than 1500 eV—in other words they have escape depths of 2-3 nm—means that the technique detects atoms in the outermost layers.

● UPS (Ultraviolet photoemission spectroscopy). In this technique photons in the energy range 10-200 eV from either a gas discharge source or an electron synchrotron (a type of accelerator) bombard a surface. The energy spectrum of the emitted electrons gives information about the states of electrons in atoms and chemical bonding. This method is contributing greatly to understanding of electronic states in pure metals, semiconductors and alloys in "atomically clean" conditions, as well as when "foreign" atoms are present on surfaces.

● EELS (Electron energy loss spectroscopy). With electron beams of energy 10-1000 eV, and through examining discrete energy losses in the range 2-40 eV, this technique gives information about the states of electrons at the surface and is complementary to UPS, being easier to perform, but more difficult to interpret. Recently, using very low-energy (10 eV) electron beams with a narrow spread in energies (10 meV) this technique has revealed the vibrational modes of adsorbed molecules, which have an energy of about 100 meV. One group of researchers has shown it can detect different bending and vibrational modes of absorbed hydrocarbon molecules. This opens the possibility of detecting the molecules that form during the intermediate stages of a chemical reaction at a surface.

● ISS (Ion scattering spectroscopy). This method directs a low-energy (about 1000 eV) beam of ions of an inert gas at a surface. The energies and scattering angles provide information about the masses of surface atoms, thus identifying them. In one experiment, double scattering processes have provided information about the spacing between adsorbed oxygen atoms and a nickel surface, showing good agreement with other results using the LEED technique.

● SIMS (Secondary ion mass spectroscopy) uses a beam of low- to medium-energy ions directed at the surface which sputters, that is knocks off, surface atoms into a mass spectrometer. This essentially destructive technique reveals the identities of atoms and compounds from the surface. A beam with a large number of ions gives a "profile" of the composition as the beam erodes into the specimen. Auger spectroscopy of the eroded surface is often used in conjunction with this technique. □

form ammonia (NH_3) in the presence of an iron surface. The reaction is:

$$N_2+3H_2=2NH_3.$$

The catalyst—the iron surface—provides a suitable environment where the reaction can proceed more easily. What happens is that the bonds of the reacting molecules can be "loosened up" and rearranged.

Chemists studying surfaces wish to understand why some surfaces are more effective than others for catalysing particular reactions. Until recently most advances in this field came by following a few semi-empirical rules and developing new catalysts by "cookery", or trial and error. Indeed, most engineers still believe that this is the most cost-effective approach! However, scientists now have the tools necessary to study most aspects of reactions taking place on the surfaces of catalysts, and they should be able to improve on the old semi-empirical rules—and maybe even understand why the rules work through a knowledge of how the molecules involved behave.

An example of the progress being made lies in the case of alloys used as catalysts. In 1950 Professor D. A. Dowden—then working for ICI—proposed that by mixing a pair of metals, the arrangement of the atomic electrons, and consequently the chemical bonding properties of the surface of the resulting alloy, might be altered from that of either of the pure components. However, in 1965 W. M. H. Sachtler and co-workers in the Netherlands demonstrated that the surface of an alloy might consist mainly of only one constituent of the alloy. During the 1970s new techniques for the analysis of surfaces have indeed confirmed that, in general, the surfaces alloys do become enriched with one constituent, and that this may also depend on the nature of the gas at the outer surface. For instance, R. Bouwman and his colleagues in the Netherlands have found that annealing alloys of silver and palladium in a vacuum produces a surface enriched in silver, whereas annealing in the presence of a reducing gas, such as hydrogen or carbon monoxide, produces a surface enriched in palladium.

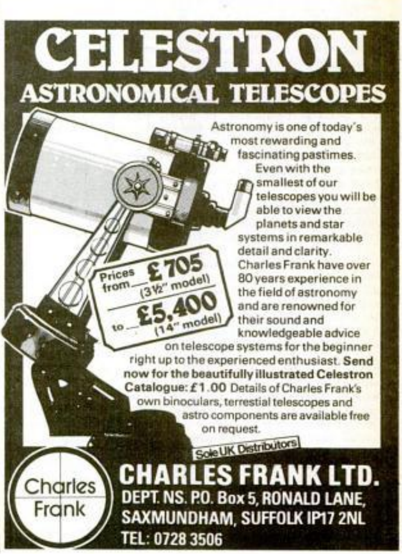
New research

The group I am with at Imperial College and other groups are now seeking ways of measuring the precise composition of an alloy's surface layer, and its underlying layers, as well as the kinetics of atomic movements that lead to changes in the composition. We also want to establish whether or not *phases*—regions of different composition—exist at an alloy's surface, which are not predicted by present knowledge of the bulk behaviour of alloys. Dowden's original suggestion may indeed bear fruit through such phases, leading to the "design" of new catalytic materials, which are more efficient and less expensive than those currently available.

We have studied in particular alloys of copper and nickel with a wide range of compositions, using Auger electron spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS) to determine the composition of the surface. Even when the bulk of the sample contains only 5 per cent copper, the heat-treated specimen can show a surface rich (more than 60 per cent) in copper. One question we would like to answer is whether the copper atoms on the enriched surfaces of our samples react chemically as copper does, or whether the adjacent nickel atoms have any influence. We could do this, in principle, by studying the reactions of gases on the surfaces, using other techniques (UPS or EELS) to investigate the electronic properties of the surface. Although there are strong similarities between copper-nickel alloys and silver-palladium alloys, we have not yet established that any significant changes in the composition of the surfaces of our copper-nickel alloys take place after annealing in a reducing gas. This is contrary to the results Bouwman's group found with silver-palladium alloys.

There are many techniques for studying surface in common use, and the list (see Box) illustrates that scientists can now determine the structure, the chemical composition, binding state, electronic states and vibrational properties of atoms in a surface. Furthermore, many of the methods that use beams of electrically charged particles, as opposed to electromagnetic radiation, can be adapted to a type of analytical microscopy, where the spatial resolution is primarily restricted by the smallest beam size that can be produced. Auger electron spectroscopy (AES) has been performed with a spatial resolution across a surface of less than 1μm, and secondary ion mass spectroscopy (SIMS) has also approached this resolution. A fundamental limit to the development of new ways to study surfaces is the need to use a vacuum to be able to get the beam of particles (or waves) to the surface, and to look at the particles (or waves) scattered, without suffering the effects of collisions with molecules of gas above the surface. If we want to study "real" surfaces at atmospheric pressure, or in liquids, we must think again about the type of "probe" to use.

Possible contenders for use as probes are electromagnetic waves, and sound (that is, pressure) waves which actually rely on the presence of a gas or liquid to be able to travel. Electromagnetic waves, particularly X-rays, could be used to provide information on the composition and the structure of surfaces. Under certain special conditions this technique could sample depths as small as 10 nm. Sound waves of very high frequency (more than 1 GHz) have short wavelengths (around 1 μm) in liquids and solids, and their reflection at surfaces can reveal information about the strengths of atomic bonds. One challenge for surface scientists is to develop practical techniques using these, or other suitable probes. □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Anonymous AID for the childless couple

Artificial insemination by donor (AID) made international headlines lately. But far more significant than the rights and wrongs of establishing elitist sperm banks are the social implications of AID

Robert Snowden
and
Duncan Mitchell
are project director and director of the Institute of Population Studies at the University of Exeter

The number of babies available for adoption in Britain has fallen dramatically (from 21 299 in 1975 to 12 121 in 1978). This highlights the plight of infertile couples who want to have a family and who, in previous decades, would have turned to adoption as a solution to their problem. For many, the scarcity of babies available has ruled out the possibility. This unmet demand has led recently to the emergence of such questionable practices as "baby-selling" and the appearance of advertisements in magazines asking for volunteer surrogate mothers. Couples who are "infertile" because of the sterility of the husband do, however, have a further option available to them—artificial insemination by donor.

The history of artificial insemination in human beings dates back to the end of the 18th century when John Hunter successfully inseminated a woman using her husband's semen. The first recorded instance of artificial insemination using the semen of a fertile male donor rather than the husband's semen (AID) appears to have been in Philadelphia in 1884. However, it was not until the 1930s, when advancing medical knowledge showed that in a considerable number of childless marriages it was the husband who was the cause of the infertility, that the possibility of artificial human insemination began to be discussed more seriously in Britain.

A small group of gynaecologists used the technique during the Second World War but AID remained virtually unknown to the general public until 1945 when the first comprehensive account was published in the *British Medical Journal*, provoking considerable discussion in the press and in parliament. As a result of this publicity, the Archbishop of Canterbury set up a commission of inquiry. The commission's report was strongly critical of AID and recommended that the practice be made a criminal offence.

Following further debates in parliament, the Feversham Committee was appointed and its report, published in 1960, also concluded that AID was undesirable. Nevertheless, AID continued to be practised on a small scale by a few infertility specialists, and as infertile couples became more aware of this possible solution to their problems, the demand for AID steadily increased. In 1970, following an increasing number of requests for information about AID, the British Medical Association appointed a panel of inquiry under the chairmanship of Sir John Peel and this produced a more favourable report, recommending that provision for AID should be made available within the National Health Service.

Approximately 10 per cent of marriages are infertile, and the husband's infertility is probably responsible in about one-third of these couples. The Peel report estimated that some 10 per cent of these couples (1600) may consider AID at sometime during their marriage. This estimate does not take into account the increasing number of couples who marry for a second time and who seek AID because the husband had a vasectomy following the birth of children of his first marriage. AID also provides a means of producing a healthy family for those couples where the husband suffers from an hereditary disease. Couples who are unable to enlarge their families because of rhesus factor incompatibility may also make recourse to AID.

Despite this increasing demand for, and acceptance of AID, we still know very little about the consequences of this procedure. The lack of evidence on which to base opinions, and the need for follow-up research has been emphasised by all the committees which have been set up to inquire into AID. Speaking in the House of Lords debate on AID and Legitimacy in 1949, the (then) Archbishop of Canterbury said, "My commission observed, very truly, that as yet there is little evidence available upon which to judge the sociological and psychological effects of AID. There are too few observed cases, and too few observed for a sufficient length of time." The Feversham Report of 1960 stated ". . . there is no doubt that all discussion of the practice is at present greatly handicapped by lack of information about what has subsequently happened to the families of those women who have received AID . . ." In 1973 the Peel Report stated, "The Panel has had evidence from several sources urging that, for psychological reasons, there should be no follow-up of children born of AID. It understands but does not entirely agree with these views. Information must be obtained on the genetic effects especially where frozen semen has been used and it is important to learn the effects, in human terms, on the development of personal relationships in families resulting from the use of AID."

This lack of evidence about the social effect of AID is, no doubt, mainly due to the atmosphere of secrecy which traditionally has surrounded the practice. There are two main reasons for this secrecy; the first is the legal position, which is far from clear.

Legitimacy of the child

As the law stands at present, an AID child is illegitimate and the fact that the husband consents to AID is immaterial. But no court in Britain has, as yet, considered the legitimacy of a child believed to have been conceived following AID and it is thought that any court would presume a child born within a marriage legitimate unless evidence was produced to the contrary. Therefore, AID babies are usually registered as legitimate with the consenting husband entering his name as that of the father. However, in so registering a child, a husband is committing perjury unless he is under the impression (rightly or wrongly) that there is a genuine possibility that he may be the father. The Council of the Law Society has recommended legal changes to enable the AID child to be deemed legitimate and the husband deemed to be the father but while judicial thinking has changed, the law remains unchanged.

The second reason for the surrounding secrecy is the belief, held until recently by almost all AID practitioners, that the child should not be made aware of his origins for fear of adverse social and psychological reactions within the family.

The secrecy which characterises AID has two components. First, there is the keeping from the AID child the knowledge of the nature of his or her own conception. This is achieved by keeping the AID secret from all relatives and friends (unless of course they are already aware of the husband's sterility) and allowing them to assume that the conception was "natural". Secondly, there are the barriers to information which are put up between the accepting couple and the semen donor which ensure that the anonymity of the donor is preserved and that the donor remains unaware of the outcome of his involvement.

The social implications of AID arise because it affects what many consider to be the basis of social organisation within our society—the family. The AID family is a very

Sue Wilks

special type of family for it is artificially created through the use of fertile semen donated by an anonymous third party, and this introduces a confusion into family relationships. AID produces a family where blood-ties on the husband's side are absent but where there is usually a pretence that they are present. This pretence keeps other kin in ignorance, and the basis of the family relationships is artificially maintained by the continuance of this pretence over a long period of time, indeed, often for life. It seems reasonable to suppose that for some AID couples keeping such a long-term secret from one's kin may well lead to stress, which has to be dealt with in some way.

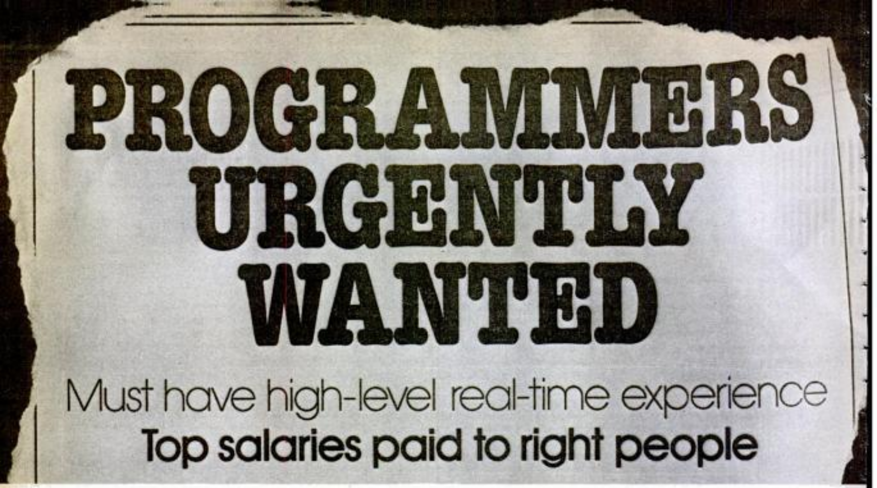
From the donor's viewpoint, AID produces blood-ties about which he is kept in ignorance—such relationships are therefore unacknowledged. Here is the converse of the situation facing the AID couple; instead of absent consanguineous relationships being claimed as at present, the donor and his kin possess consanguineous relationships with the AID child but these are denied. This uncertainty about blood-ties with unknown offspring may also produce difficulty for the donor and his kin; indeed, in a recent television interview a young medical student donor confessed that his mother found the possibility that she might have several unknown "grandchildren" very disturbing.

It is interest to ask why this secrecy has generally been regarded as necessary, both by parents and by AID practitioners, as the reasoning which lies behind this practice is not normally made explicit. It may be that secrecy is advised to protect the child from the painful discovery that his social father is not his biological father, and from all the subsequent problems of self-identity that this may cause. Or it may be that secrecy is maintained to protect the husband's feelings and to enable the couple to appear "normal" by having children just as other couples do. It is, perhaps, the current legal position which defines an AID child as illegitimate which is the most likely reason for advising secrecy. Derek Gill, in his book *Illegitimacy, Sexuality and the Status of Women*, concludes that it is unlikely that stigmatisation of illegitimate reproduction will disappear entirely from the Western social scene in the immediate future.

Whereas the unmarried mother of an illegitimate child may find it difficult to hide the result of her conception and pregnancy, the AID mother who is living with her husband will experience no such difficulty provided that knowledge of her husband's infertility is kept secret. But some practitioners are now questioning the wisdom of such secrecy and pretence.

There may be good reason to maintain confidentiality and anonymity with regard to the donor but the element of secrecy within the AID family, which keeps close relatives in ignorance and which withholds from the AID child the true circumstances of his own conception, is more difficult to justify. This denial of the true state of affairs and pretence of "normality" is reminiscent of the practices followed by adoptive parents several decades ago. Since then it has been established that the emotional energy spent on denial and concealment is better expended in facing and resolving the problems inherent in adoption. But this policy has undoubtedly been facilitated by the provision of a legal framework whereby the adopted child has a recognised status in law. Social research is urgently needed to provide evidence for the formulation of an adequate policy which makes provision for the status and well being of AID children in our society without the need for subterfuge and secrecy.

In this article we consider AID only in relation to the needs of infertile couples, but recently publicity has been given to isolated instances of single girls and lesbian couples who have had their requests for AID granted. In the present climate of the "woman's right to choose" this demand is likely to grow. ☐



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Chimps wise up to human deceit

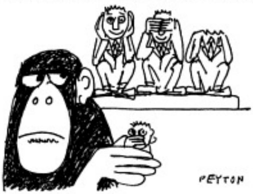
Dennis Lendrem

Animals can tell lies—and what is more they can tell which humans are deliberately misleading them. Guy Woodruff and David Premack of the University of Pennsylvania have collected strong evidence for these controversial claims in a study of deceit in four African-born chimpanzees, Sadie, Bert, Luvie and Jessie (*Cognition*, vol 7, p 333).

A single room with a wire mesh pen in one corner formed the setting for the experiment. The researchers hid a piece of fruit or a sweet under one of two containers in the room. The chimp was shown where the fruit was hidden, and then led into a pen in the corner. A human trainer was shown into the room, and told to guess under which container the fruit was hidden. Each chimp had two trainers, one cooperative, the other competitive. If a cooperative trainer guessed where the fruit was hidden he gave it to the chimp.

If the competitive trainer guessed correctly he ate the fruit, and if he guessed incorrectly the chimp was awarded the fruit. Both cooperative and competitive trainers were instructed to make their choice according to the chimp's signals. The chimps signalled by pointing to, gazing at, or actually approaching (within the confines of the pen) the container that concealed the dainty morsel.

The chimps behaved almost exactly as self-interested human beings might have done. If the trainer was cooperative, the number of correct choices he made increased during the course of the experiments. On the other hand, if the trainer was competitive the number of correct choices based on the chimp's signals actually fell, first to chance levels, and then to levels significantly below chance.



In other words, chimps started by helping competitive trainers, then withdrew that help, and then they actually made misleading signals. This conclusion was confirmed by videotapes of the chimp's signals during the experiments. Watching the tapes, experimenters found that the frequency of all signalling fell if the trainer was competitive. Moreover, once the chimp realised that his trainer was competitive, he dropped pointing and approach signals altogether. Later the chimp took up an active form of deceit, and directed the trainer to the wrong container!

The two scientists then changed the rules. They made the human trainer the informed partner. By doing this they could see whether chimps can learn to ignore misleading information from an unreliable source. Two of the chimps did just that. At first they took the misleading signals from the competitive trainer at face value. They eventually ignored these signals, and then learned to choose the opposite container to the one signalled. With the cooperative trainer they chose the container signalled.

It seems that chimps will not only deceive their human trainers, they will also evaluate them for their reliability! □

New model for ball lighting

A new explanation for the peculiar phenomenon of ball lightning has come from G. C. Dijkhuis of Zeldenrust College at Terneuzen in the Netherlands. He consigns to oblivion previous explanations, which have ranged from chemical reactions, through glow discharges and microwave action, to nuclear reactions and the annihilation of antimatter, by the fact that a metal aeroplane is airtight and magnetic field-proof. The answer, he says, must lie in simple electric charge (*Nature*, vol 284, p 150).

Apparently reliable witnesses have seen incandescent balls of light floating about during thunderstorms for centuries, but because it is virtually impossible to explain ball lightning, most physicists for long regarded it in the same light—so to speak—as UFOs, levitation and things that go bump in the night. Ball lightning has become a respectable subject in the past few years, largely because a football-sized specimen presented itself to physicist Roger Jennison in 1963—floating down the aisle of a commercial airliner on a night flight from New York to Washington. While other passengers gaped, Jennison quickly estimated its size, speed, colour, light and heat output and its apparent darkening towards the edge (*Nature*, vol 224, p 895).

Dijkhuis's new theory runs roughly as follows. Split off electrons from air atoms, and the result could be an ionised plasma ball. As a normal plasma ball would puff out of existence in a thousandth of a second, Dijkhuis suggests that the ball is superconducting. But although superconductivity (zero electrical resistance) will have the required effect in stabilising the plasma, it is a property usually associated with very cold metals, not extremely hot gases. Dujkhuis rescues this situation by making the charge carriers not individual electrons but tiny whirling vortices only a millionth of a centimetre across. The ball is thus "a sponge-like structure of tenuous vortex cores nested in a dense ambient plasma".

As ball lightning floats in air, its average density must be similar to that of air. Dijkhuis calculates that a typical ball has a pressure within it of 180 atmospheres, constant throughout, but its density drops from six times that of normal air just within its surface to three-millionths of the value at the centre. Over the same distance the temperature rises from 4000°C to 100 million °C—seven times hotter than the temperature at the Sun's core!

Dijkhuis doesn't explain why the scorching centre doesn't heat up the outside layers and destroy the ball, nor what conditions are like at the surface where ordinary air meets the dense hot plasma of the ball. One thing can be safely predicted about Dijkhuis's work, anyway: like all its predecessors it won't finally lay the ghost of the ball lightning mystery to everyone's satisfaction. □

Bio-war in the greenhouse

Botanists may at last have developed an effective way of eradicating one of the most persistent pests in glasshouses, *Myzus persicae*, the peach potato aphis.

Myzus persicae is an aphis, or plant bug, that attacks a variety of crops, and is especially hard to control in commercial chrysanthemum glasshouses. When sparsely scattered over the plants, it does little damage, but in the warm humid glasshouse, it multiplies rapidly, and attacks the flowers, making them unsaleable. Pesticides are only partially effective, because the aphids congregate on the underside of the tightly packed young leaves where the spray cannot reach.

R. A. Hall and H. D. Burgess of the Glasshouse Crops Research Institute, at Littlehampton, came across *Verticillium lecanii*, a tropical fungus related to a plant pathogen that causes wilt in tomato plants. *V. lecanii* is known to attack tropical insects, so Hall and Burgess cultivated it in a nutrient solution and sprayed the fungal spores on to glasshouse chrysanthemums most susceptible to aphis attack (*Annals of Applied Biology*, vol 93, p 235). Two factors favoured the fungus. One is the high temperature and humidity of the glasshouse; the other is that *Myzus* is a restless bug. Even when infected, it wanders among its siblings spreading disease, so that even those clustered under the leaf rosettes are killed.

Results have been spectacular. In some cases the aphids have disappeared completely, though success with a couple of minor insect pests has been uneven. But Hall and Burgess hope that the tests they are now doing will confirm their results, and succeed even with the minor pests. Chrysanthemum growers will be watching their progress with interest. □

Genetic engineering peps up biocatalysts

John Newell

Bacteria, already widely used to make antibiotics, enzymes and vitamins, and now being engineered to make vaccines and interferon, should play an important part in the production of plastics, paints and pesticides within the next 10 to 15 years. Howard Dalton of the Biological Sciences Department of Warwick University has been investigating bacteria used in making animal feed from North Sea gas and finds that they can also be harnessed to produce materials ranging from plastics and paints to pesticides. For example, the bacteria can oxidise hydrocarbons, much more efficiently than conventional industrial processes. The snag in using bacteria, though, is their relatively low productivity. But genetic engineering now offers the means of boosting productivity hundreds of times over, thus making bacterial biotechnology more economically attractive.

Dalton's group began work on *Methylococcus capsulatus*, a strain of bacterium that feeds on and oxidises methane, and which was originally isolated from the Roman hot springs in Bath, in the early 1970s. *Methylococcus* was then considered as a source of single-cell protein for animal food. Such possibilities were attractive because simultaneously the anchovy fisheries and soya harvests had failed thus forcing European producers to seek an independent source of protein for farm animals. But as the price of gas rose, the group turned to other more valuable products that might be made from it.

The researchers discovered that *Methylococcus* can oxidise several other hydrocarbons besides methane. For example, it can oxidise ethylene to ethylene oxide, which is a difficult reaction to perform by other means. The bacterium can also oxidise propylene to propylene oxide, which, as carried out at present in chemical industry, is an expensive and inefficient reaction. Both these oxidations form part of the first steps in making plastic foams and paints among other products; and this suggested an immediate application for the discovery.

About £5 thousand million worth of propylene oxide, at £400 per tonne, is being produced by conventional techniques from propylene every year, worldwide. Other important oxidations which Dalton finds *Methylococcus* can perform effectively include: benzene to phenol, toluene to cresol and methanol to formaldehyde. Among these, the toluene to cresol oxidation looks especially attractive because of the big jump in value; from £220 per tonne for toluene to £600 per tonne for cresol.

The obvious attraction in using *Methylococcus* in such processes is that it achieves its oxidations at around 40°C and at normal pressures, compared with several hundred degrees and the high pressures needed in conventional processes. Even when the maximum possible use is made of the process heat needed for conventional hydrocarbon oxidations, a manufacturing process that involves bacterial action still results in a considerable energy saving.

Dalton's breakthrough is that he has shown how to improve the hitherto low productivity of oxidation by bacteria. He and his colleagues are able to engineer *Methylococcus* by multiplying the quantity of DNA coding for the enzyme responsible for the vital oxidations many times over. So the bacteria make much more enzyme than usual; they are hundreds of times more productive. The trick is to insert the DNA coding for the enzyme into plasmids—cell structures that can reproduce autonomously from the bacterium. These are then multiplied in *Methylococcus*. In the future, perhaps, other bacteria may prove more suitable for some industrial processes. By allying this genetic engineering with the selection of strains of bacteria which give the highest rates to begin with, and which are not poisoned by the product they produce, several bacterial oxidations are made more efficient.

The usual way to utilise bacterial enzymes is to isolate them from the bacteria. Cetus, an American bioengineering company that works along similar lines with *Methylococcus*, is pursuing this route. However, there are considerable problems with the instability of the isolated enzyme and in supplying it with energy in an appropriate form. Dalton's group wants to be able to use whole bacteria either grown in reactors, similar to those used by ICI in its plant for making single-cell protein from ethanol, or immobilised on stocky glass or nylon beads.

Dalton believes that feedstocks for paints, plastics, pesticides and so on will, be made by bacteria on an industrial scale within 10 or 15 years, in Britain, Europe, the United States and Japan. *Methylococcus* may find its first application in expensive pharmaceuticals and perfumes—the manufacture of which involves oxidation steps that are especially difficult to perform by other means. In the near future another attractive use could be in making new variants of antibiotics to combat resistant bacteria; the oxidative reaction is particularly appropriate for this. ☐

London larders are laced with lead

London soil is so heavily contaminated with lead as to make it unsuitable for allotments, according to B. E. Davies, of the Department of Geography at the University of Aberystwyth. Davies found very high concentrations of lead in the soil in central London, and a gradual decline with distance away from the centre *(Journal of Agricultural Science*, vol 93, p 749).

Davies also analysed crops of radishes grown on the same sites, and found they all contained lead in amounts sufficient to present a health risk. He concludes that most soils within a 10 km radius of Marble Arch are likely to be contaminated with lead, and as such are likely to present a significant health hazard if used for the production of food. ☐

Asteroids cut by grooves

Up to a quarter of all asteroids smaller than 100 km in diameter will be covered with long trough-like grooves, according to P. Thomas and J. Veverka of Cornell University's Laboratory for Planetary Studies. This prediction has come from an analysis of one of the most surprising results of space missions to Mars: the discovery of long trough-like grooves on the surface of its inner satellite Phobos (*Icarus*, vol 40, p 394).

The first theory was that the grooves, which are 150 metres wide and 15 metres deep, were caused by tidal stresses pulling Phobos apart. An early alternative was that they were made when Mars captured Phobos. But later investigations showed that they are closely associated with the largest crater on the satellite, Stickney, and researchers now believe that they were formed by the impact that created Stickney.

NASA

Viking Orbiter 1 has shown astronomers that there are trough-like grooves on Martian satellite Phobos

Using the theory developed for Phobos, the authors speculate about the effects of impacts of different energies on asteroids. Below a certain critical energy a simple crater is formed; above it, grooves result. A still more energetic impact causes grooves and spallation of material from the antipode or even complete fragmentation of the asteroid. The appearance of the grooves will depend on the nature of the asteroid and in particular whether or not it has a thick regolith—loose weathered material between the ground surface and the bedrock. The metallic M-type asteroids are believed to have very little regolith, so the fractures will be sharp. The stony S-type asteroids, on the other hand, have a deep regolith, which can drain into the fractures giving them a rounded appearance. ☐

The mystery of the missing muscle fibre

Muscle biologists have been baffled by the recent discovery that young animals lose a high proportion of muscle fibre.

As we get older, the size and strength of our muscles decrease. The number of fibres in a given muscle also falls from youth to old age. Until recently, it was assumed that the loss of fibres occurs late in life, but two recent studies show that this is not so. E. C. Ihemelandu of the University of Nigeria reported that in dogs a given muscle loses up to 30 per cent of its fibres between 2 and 12 months of age. D. K. Layman and his colleagues at the University of Minnesota recorded losses of up to 40 per cent in the 4½ months after weaning in rats.

Layman and his colleagues point out that it seems nonsensical for an animal to produce muscle fibres only to lose them while it is still in the prime of life. The fate of the missing muscle fibres is also a mystery. So far, no one has found any sign of degeneration of muscle fibres, so where do they go? The Minnesota group makes the intriguing speculation that the fibres may fuse with one another.

This highly speculative idea fits in with the scientists' observation that the total number of nuclei in a muscle does not decrease with the passage of time as it would if muscle fibres were simply lost. That the muscle fibres also get bigger supports the hypothesis that the fibres fuse together.

These new results may cause a few sleepless nights for neurobiologists because the large-scale loss and/or fusion of muscle fibres will result in a continual readjustment of the precisely regulated nerve supply to muscles. As the nerves control many of the functional and biochemical characteristics of the different kinds of muscle fibre, there could be a ceaseless shifting of the properties of individual muscle fibres. ☐

K. R Porter

Electron micrograph of striated muscle. Do muscle fibres fuse together as young animals grow?

Direct drilling up and down the country

Observant readers in the English countryside last autumn may have been surprised to see farmers drilling unploughed fields, sowing their seed into the burnt stubble of the previous crop, without first ploughing the land. This practice of *direct drilling* is fast becoming of major significance for the cultivation of winter cereals, but farmers are still unsure as to whether their land is suitable for this technique. A group led by Bob Cannell of the Agricultural Research Council's Letcombe Laboratory in Wantage, has discovered where farmers could benefit by this technique (*Outlook on Agriculture*, vol 9, p 306).

The researchers restricted their attention to the cereal growing lands of the east of Britain, where they identified three categories of soil. On chalk, limestone and well-dained loamy soils, yields comparable with those obtained by conventional means can be obtained by direct drilling. But land which is only moderately well drained gives acceptable yields for winter cereals, but yields from spring-sown crops could be substantially reduced. On light sandy soils, and the wet alluvial and clay soils farmers using the direct-drilling technique run a considerable risk of reduced yields, particularly on spring-sown crops.

Research into cultivation without ploughing has been going on since about 1961, when it was realised that a shallow seed-bed is all that is required for cereal growth. The function of the plough is to bury the trash from the previous crop, and thus prevent weed growth, but now this can be controlled chemically.

Experience has shown that yields of winter cereals are in the long term about the same for both direct drilled and conventionally cultivated crops. Consequently the benefit to the farmer comes from the advantages of timeliness of cultivations, permitting him to increase his area of autumn-sown cereals which show an average greater yield of 1 tonne/hectare over the corresponding spring-sown crop. Also many studies have shown that under direct drilling better soil conditions develop without the major soil disturbance of ploughing, and this can result, in some circumstances, in an increase of crop yield.

Equally important is the increased speed of the drilling operation, which permits the farmer to sow a much larger proportion of his area near the optimum time. This factor is particularly critical for crops sown in spring, for which there is a marked decrease in yield if the crop is sown late. However, spring-grown crops are also considerably more at risk in direct-drilled land than their winter-sown equivalents, probably because they have a shorter period to develop adequate root systems.

Early experiments were conducted with light soils, but recently they have been extended to a wider range of soil types. The results from direct drilling are found to depend on the soil type, and consequently farmers wanted to know if their soils were suitable. ☐

The Universe shrinks before powerful statistics

Our Galaxy is considerably smaller than astronomers believe, say two British astronomers who have introduced a powerful statistical technique for calculating star distances.

Victor Clube and John Dawe of the Royal Observatory, Edinburgh, conclude that all the distances to other galaxies should be decreased, reducing the size and age of the Universe below even recent low estimates (see this week's issue, p 844). Clube and Dawe measured star distances independently of the usual trigonometrical parallax technique (apparent change in a star's position as the Earth moves around the Sun) and the moving cluster method (perspective causes a moving star cluster's apparent size to change). They have updated two older methods: those involving secular and statistical parallaxes (*Monthly Notices of the Royal Astronomical Society*, vol 190, pp 575 and 591).

Because the Sun is travelling towards the constellation Hercules, observers on Earth see other stars moving in the opposite direction. This "secular" motion depends on the distance of the star from us—just as a train passenger sees a telegraph pole shoot backwards more rapidly than a distant tree. In addition, each star has its own individual motion so astronomers must take some kind of average.

The best way is to apply the method to stars of the same type, having the same intrinsic luminosity. The results of the secular parallax method are then expressed not as individual star distances, but as the intrinsic luminosity of the star-type. Astronomers then have a "standard candle", and the distances to other stars of the same type can be calculated from their apparent brightnesses by the inverse-square law.

The second method uses the individual motions of the star. Astronomers consider many stars of the same type: their average speed toward or away from us (radial motion) should be equal to their average speed across the sky (transverse motion). The former can be measured spectroscopically; the latter is related to the measured angular speed and the distance. So the distances, and more important the luminosity of a class of star, can be determined statistically.

Traditionally the "standard candle" and statistical methods have been used separately, and the results averaged. But Clube and Dawe used a powerful statistical method, a "maximum likelihood" technique, that takes all the data together and selects the most likely values of the parameters (actual luminosity, speed of the Sun, and so on) that will fit the observations, allowing for experimental error.

They used the method to calculate the luminosity of RR Lyrae variable stars (named for their prototype in the constellation Lyra, the lyre), a very important "standard candle" because the ▶

◀ luminosity of all RR Lyrae (averaged over their period of variation) is identical. The improved technique shows that they are only two-thirds as bright as previously thought (the new absolute magnitude is +1·0).

Study of the RR Lyrae near the centre of the Galaxy has always been one of the best ways of determining the Sun's distance out—and thus the scale of the Galaxy.

Clube and Dawe's recalibration brings the Sun's distance from the centre of the Galaxy from the usually-quoted figure of 33 000 light years (10 kiloparsecs) down to only 23 000 light years, reducing the Galaxy in proportion to only three-quarters its "nominal" size. At around 70 000 light years diameter, it becomes a rather weedy spiral galaxy, only half the size of the neighbouring Andromeda Galaxy.

Can the difference be due to an unsuspected fault in the new method? Derek Jones, one of the editors of the *Monthly Notices*, challenged Clube and Dawe to analyse a set of synthetic observations that he'd produced with a random number generator, and included in the challenge Dutch astronomer André Heck who has developed a similar technique. Dawe says "this must have been one of the first times that authors of a statistical technique have been subject to such a challenge; fortunately both André and ourselves came up with the correct solution".

Clube and Dawe have had a hard struggle to get their work into *Monthly Notices*, a journal which has a reputation for reliable, strictly-refereed papers. The editors normally accept or reject on the basis of one or two referees' reports; Clube and Dawe's papers went the rounds of three referees and an arbitrator. It took two years from submission to publication in a journal whose normal turn-round time is well under a year.

Perhaps this reflects a reluctance on the part of astronomers to accept one major consequence of the new results: that all extragalactic distances decrease. The Magellanic Clouds, our nearest neighbours, are reduced in distance by 40 per cent, to 150 000 light years for the Small and 125 000 light years for the Large Magellanic Cloud.

Such a change would undermine the current cornerstone of extragalactic distance measurement: the use of the Cepheid variable stars. Clube and Dawe confirm the accepted luminosity of Cepheids in our own Galaxy, but make those in the Magellanic Clouds fainter. All extragalactic distances are then scaled down, meaning that the Universe is smaller and younger. Barry Madore at Cambridge University has already questioned the accepted calibration of Cepheids, and Clube and Dawe's work is strong support: Jones calls their contribution "two very good and sound papers".

Other astronomers have adduced other evidence for reducing the distance of galaxies. Dawe says "we are striking directly at the foundations of the establishment viewpoint but we are not alone in questioning the orthodox line". A reply is now due from the "orthodox" astronomers, who have followed the painstakingly detailed studies made 10 years ago by Allan Sandage and Gustav Tammann. ☐

Culture of organs for transplant

A team of Australian researchers has come up with a new theory for why people reject transplanted organs. Their ideas have led them to develop an alternative way of preparing organs before they are transplanted.

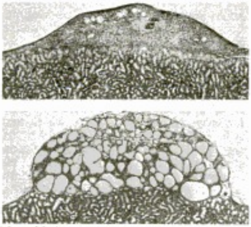
Scientists have long thought that tissue or organ transplants are rejected when the body's immune system detects antigens on the "intruding" material and activates specific T cells (lymphocytes). Once activated, the T cells attack and kill the cells of the graft.

This view implies that all antigens will stimulate differentiation of T cells, but in recent years it has become clear that this is not always so. In a forthcoming paper in *Transplantation*, Dr Kevin Lafferty of the Australian National University's John Curtin School of Medical Research suggests that differentiation of T cells occurs only when two signals from certain stimulator cells simultaneously reach precursors of the T cells. The two signals consist of antigen located on the surface of the stimulator cells and a substance emitted by them, which the Australians call lymphocyte co-stimulator.

Although all foreign cells have the surface antigen needed to stimulate T cell differentiation, not all produce lymphocyte co-stimulator. Indeed, Lafferty and his colleagues have evidence that in transplanted tissue the co-stimulator, which must be present to cause rejection of foreign tissue, is produced by passenger leucocytes that originate in the blood and lymph system of the donor. These passenger leucocytes, it seems, produce these co-stimulators only when they are active in metabolism. So it should be possible to facilitate organ or tissue transplants by treating the tissue in culture to eliminate (or at least to inactivate) the passenger leucocytes they contain. Such procedures could allow doctors to dispense with the drastic techniques that they currently use to suppress the recipient's immune system.

The idea of culturing organs before grafting them into other individuals has been around for many years, but for a number of reasons it has been out of fashion. Recently it has enjoyed a small revival: for example, a research group at Hammersmith Hospital has been using it with some success to transplant kidneys between different strains of laboratory rats (*New Scientist*, 10 January, p 75).

On the other side of the world, Lafferty and his team have also produced some promising results. They have transplanted thyroid tissue from individuals of one mouse strain to another after culturing the tissue under conditions designed to kill off any blood-derived cells in the thyroid tissue. They found that the mice receiving the transplant rejected untreated thyroid tissue within 15 or 20 days of grafting. By contrast, treated tissue in most animals has shown no sign of rejection 1½ years later.



Thyroid tissues from a mouse transplanted onto the kidney capsules from a mouse of a different strain. Untreated tissue is rejected (above) two weeks after grafting, while cultured tissue (below) is healthy one month after grafting

The transplantation of thyroid tissue has theoretical interest, but little practical application. Successful transplantation of pancreatic islets, on the other hand, could do much to assist in the treatment of juvenile onset diabetes.

Transplanted pancreatic islets usually provoke a strong immune reaction in the recipient, so they are difficult to transplant even when drastic techniques for suppressing the immune reaction are applied. But islets can be maintained in organ culture, and several research groups have attempted to transplant them this way.

In the successful technique for transplanting thyroid tissues, the material is cultured in an atmosphere consisting of 95 per cent oxygen and 5 per cent carbon dioxide to condition the cells before grafting. Single islets cannot be cultured in an atmosphere containing so high an oxygen concentration. But Lafferty and his colleagues K. M. Bowen and L. Andrus have found that they can get round the problem by fusing 50 or so islets together during culturing. So far, they have observed little evidence of rejection of pancreatic islets transplanted from one mouse strain to another for three months after grafting (*Lancet*, 1979, vol 2, p 585).

Lafferty and his co-workers point out that, in its present form, their method is technically difficult and could not be adapted for larger organs such as kidneys. However, it should be possible to develop techniques for removing or inactivating the main immunity-stimulating components of such organs. ☐

Technology

Machines break down language barriers

The next group of people who fear that computers will make them redundant may be translators. Researchers in the United States are near to perfecting equipment that translates text from one language to another—with only limited assistance from people. The system, which could be a boon to many organisations ranging between multinational corporations and language schools, should soon be available commercially. This is the view of Dr Alan Melby, assistant professor of linguistics at Brigham Young University in Utah where the equipment is being developed.

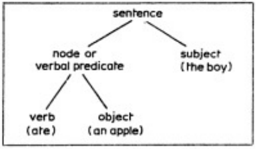
The European Commission in Brussels is among the organisations interested in automatic language translation. In 1979 it started a three-year project to research ways of translating papers into different languages. This is mainly to cut down on the huge cost of employing translators.

Researchers have studied techniques of translating languages by machine for at least 30 years, but so far with limited success. The main problem lies in trying to relate the grammatical rules which define the structure, or *syntax*, of a sentence to the meaning, or *semantics*, of the group of words. For example, the sentences "He washed the dishes with a rag" and "He washed the dishes with Susan" have a similar structure but different semantic contexts.

Most researchers of machine translation have tried to perform a syntactic analysis of a group of words followed by some automatic way of working out the words' meaning. The simplest technique is a direct word-by-word translation with a limited search for the syntactic context of that word, for example by looking for nearby articles and pronouns.

Researchers at Brigham Young University, however, have adopted a novel approach. They ask people to "converse" with the computer during the initial analysis. In effect, humans help out the machine a little. The result is that the computer makes sense of what it is translating from both a syntactic and semantic viewpoint.

The science of machine translation is an extension of linguistics research: once the language analysis has been refined, the computing tasks become relatively trivial. The Utah system is based on a model of language structure developed in the 1960s and known as junction grammar (JG). The essence of JG is the "J-tree" representation, which breaks down a sentence into a kind of "family tree" in which the language equivalent of a "mother" (or father) in the tree is known as a "node".



"Family trees" of sentences like this one could help to put translators out of work

For example, the sentence "The boy ate an apple" is translated into the shape of the family tree shown in the diagram. In JG, a sentence in its simplest form contains a subject ("the boy") and a node called the verbal predicate ("ate an apple"), which itself subdivides into its own mini-tree or subjunction. This leads to the rest of the sentence—"ate" and "an apple". From such simple trees do mighty theories grow.

In JG, the meaning of a sentence is computed from the relationships between the individual meanings of the nodes. For example, returning to the ambiguity about washing dishes with rags or Susan, a JG analysis in the first sentence would link the object ("rag") to its prepositional node "with". But with the second sentence, the analysis would link Susan directly with the "he" of the predicate "he washed dishes", creating a different form of subjunction.

The example indicates that this kind of analysis takes account of both syntax *and* meaning. In the Utah system, the decisions about the appropriate meaning of a particular sentence are not yet performed by computer; instead a person instructs the computer which meaning to adopt in a particular context. The computer then analyses and records the relevant J-trees, which are stored in computer code on magnetic discs and tape.

With these computerised J-trees, the source text can be translated into a number of "target" languages using computer programs which carry out the J-tree-to-language translation rather than direct language-to-language conversion. The Brigham Young workers have developed their techniques to translate from "J-tree" English to Spanish, Portuguese, German, French and Chinese.

Originally, the researchers hoped to develop techniques derived from artificial intelligence research which would automatically carry out the task of assigning meaning to ambiguous sentences. This would mean that even the limited help of a person would not be needed. But Melby says that, for the foreseeable future, the partnership between man and machine in the system he is now developing offers the best chance of success. ☐

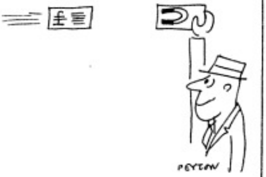
Banking on electronic cash payments

A new method of making cash transactions could be on the way with special credit cards issued by two British banks. The National Westminster Bank and the Clydesdale Bank of Scotland have given customers magnetically-coded cards which they can use to deposit or draw out money.

The customer visits his or her bank in the normal way but instead of writing out either a cheque or filling in a deposit form, he hands over his card. The teller checks that the person is the card's true owner by asking him to key in a special number: then the transaction is carried out by the teller operating a computer terminal. The system should help to reduce paperwork and cut the fraudulent use of bank cards.

The National Westminster Bank is issuing five million customers with the new cheque cards, which are watermarked, using a tape recording technique, with a code that gives the owner's identity. Initially, the customers will present their cards with cheques in the same way that they use conventional credit cards. Eventually, however, the card holders will be able to deposit or withdraw money from banks whose staff have been supplied with the necessary terminals.

The system could also be extended to shops. Big stores could be given similar terminals that staff would operate to let card holders buy goods without handing over cash.



Developed by Emidata, part of the EMI group, the tape-recording technique—called watermark magnetics—permanently records data onto a piece of magnetic tape. This is then fixed to the plastic cheque card. In the conventional method of recording data—such as on a computer tape or a music cassette—the information can be erased by passing it through a sufficiently strong magnetic field.

This will not happen with the new cards. Emidata creates the watermark by passing a piece of tape through a magnetic encoding machine. This happens while the solution that bonds the ferric oxide particles in the tape to a backing material is still wet. Then the particles are "locked" into place with fast-drying chemicals.

The Clydesdale Bank of Scotland already operates a "chequeless" transaction network based on magnetic cards (not of the watermarked variety) that operates on similar lines to the system planned by the National Westminster Bank. Over the past year about 700 terminals have been installed in the bank's branches. ☐

How Britain could be big in semiconductors

Pulling crystals can be profitable

Britain could make a big impact in the next stage of the semiconductor revolution—not by designing new integrated circuits but by supplying the substance from which they are made. This is the view of Rowland Ware, manager of the materials division of Metals Research, a company that is one of the world's leaders in making gallium arsenide. Many computer specialists think this substance could eventually become a rival to silicon, the material from which almost all the world's semiconductor chips are now fabricated.

The world uses 2000 tonnes of silicon yearly for making integrated circuits. Applications for integrated circuits are being discovered so fast that this figure is increasing by 20 per cent annually. (There is little chance of the world running out of silicon: the Earth's crust contains an estimated 8×10^{18} tonnes of it.) By contrast, electronics companies today consume only about 20 tonnes of gallium arsenide per year. Most of this is used in light-emitting diodes.

However, this picture could soon change. In theory, gallium arsenide is most suitable for making integrated circuits. Its internal structure is such that electrons travel more quickly through it than through silicon. This opens up the possibility of making digital circuits or "switches" that operate much faster than silicon devices.

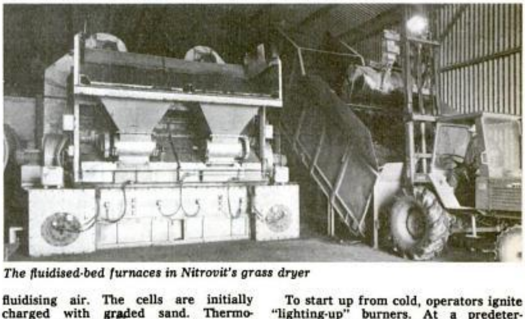
Until recently, however, there was not much progress in making such circuits. Gallium arsenide is more expensive, and more difficult to purify than silicon. And electronics engineers found they could not use the same techniques to define circuit lines on gallium arsenide that they have so successfully applied to silicon. Engineers in the US, however, have overcome the technical difficulties and started to make densely-packed chips made from gallium arsenide (*New Scientist*, 24 January, p 237). According to the British consulting firm Infotech, large-scale integrated chips made from gallium arsenide will be "freely available" in the mid-1980s.

Metals Research, a subsidiary of Cambridge Instruments (CI), which is based near Royston, Hertfordshire, sells about 1 tonne of gallium arsenide per year. It also sells the equipment called "crystal pullers" with which the material is made.

Ware is now putting plans to expand production to the main CI board. He says that by 1990 gallium arsenide chips could constitute 10 per cent of all the integrated circuits sold: according to current trends, the world will then need about 1200 tonnes of gallium arsenide per year, or 60 times more than today's figure. Ware says his firm could expand its production fivefold by 1985.

The synthesis of gallium arsenide is based on the "crystal pullers" developed at the Royal Signals and Radar Establishment in the 1960s. Soon afterwards Metals Research started to sell the systems. There are two steps to the process. Gallium and arsenic are first mixed sult is polycrystalline gallium arsenide. under pressure at about 800°C. The re- This is then recrystallised to give the monocrystalline form required for integrated circuits. A pure specimen of monocrystalline gallium arsenide is suspended in the molten substance and slowly drawn out to give a long cylindrical mass of the substance in its changed structural form. The reaction vessels in which these chemical steps take place can produce as much as 1 kg of the monocrystalline material in a process that takes a day. The biggest vessel that Metals Research sells costs £250 000 and is 4 metres tall. □

Grassy eyed over saving energy



The fluidised-bed furnaces in Nitrovit's grass dryer

A company that dries grass to make animal fodder has reduced fuel costs by adapting one of its dryers to fluidised bed combustion. Run by Nitrovit of Kettlethorpe, Lincolnshire, the equipment produces a tonne of dried grass at half the cost of drying the same quantity of material with conventional oil-fired heating.

The dryer was converted to the fluidised bed principle in 1978, according to proposals from the National Coal Board and G. P. Worsley, a firm that makes coal-handling equipment. Nitrovit has recently finished its first prolonged spell of drying with the new equipment. In fluidised bed combustion, coal is burnt on a layer of sand through which air is passed. The technique provides a way of burning low-grade coal to give a useful heat output, and so offers heat cheaply.

The grass fed into the dryer is harvested during the summer months, when its moisture content is about 70 per cent. This proportion has to be decreased to 12 per cent.

Each of the dryer's two coal-fired cells comprises a rectangular chamber that is lined with refractory bricks and fitted with an air distribution system to admit fluidising air. The cells are initially charged with graded sand. Thermocouples in the sand bed indicate its temperature: operators keep this constant by varying the rate at which coal is fed into the cells. An alarm sounds in the control cabin if the temperature varies too widely.

Each cell has an oil-burning precombustor which heats the sand bed at the start of the process. Fans on top of the cells force air through them.

To start up from cold, operators ignite "lighting-up" burners. At a predetermined minimum temperature, coal is manually fed into the cells, and damp grass is channelled into the dryer adjacent to the cells. As the beds' temperature rises, the air fans are started and the coal feed switched to automatic. Finally, the rate at which grass is fed into the cells is matched to the beds' temperature to make sure the dryer is kept at the required temperature. □

Californians take a shine to crystal cathedral

The latest landmark in southern California is an all-glass cathedral as big as Notre Dame in Paris. When it opens later this year in Orange County, south of Los Angeles, the building will seat 4000 people. Others who do not want to leave the comfort of their cars can follow services while sitting in their vehicles: doors 27 metres high will open up to permit views of the interior from the parking lot outside.

The $10 million structure will be the home of the Garden Grove Community Church, an organisation founded more than 25 years ago by the Rev Robert Schuller. Designed by architects Philip Johnson and John Burgee, the building's walls and roof are made of reflective glass. Most of the Sun's rays bounce off this material, keeping the inside of the church relatively cool.

The star-shaped cathedral comprises a free-standing concrete balcony and office structure enclosed by a cage of steel and glass. The structure houses a 50 m long altar at which as many as 500 people can kneel at a time. Up to 700 musicians can be seated in the massive choir loft.

Don Allen, Los Angeles

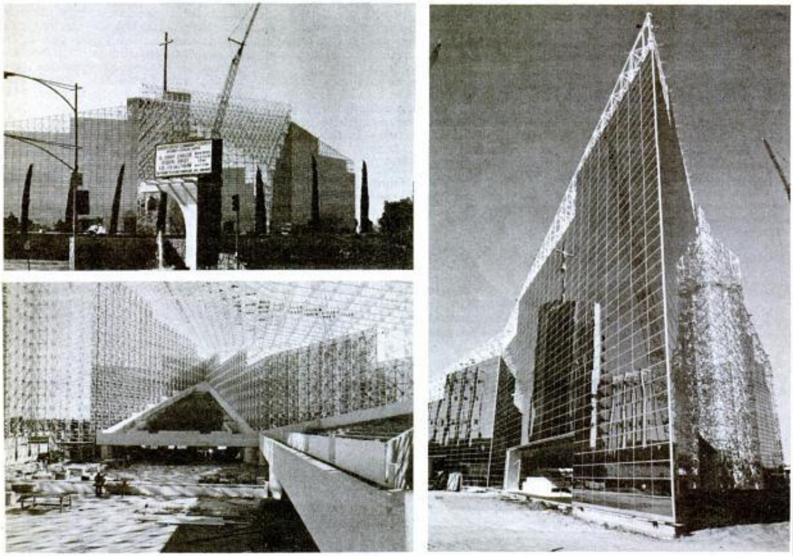
The crystal cathedral is 124 m long and 62 m wide at its broadest point. The highest part of the structure is 40 m above the ground. The foundation of the building was formed by 325 poured-in-place concrete pylons, each 13 m deep; more than 20 000 tonnes of concrete were used in the building. A perimeter wall which encloses the office area helps to support the huge web of glass supported on steel that forms the main part of the structure.

The steel frame comprises about 120 trusses which were assembled at a steel plant and taken to the construction site in lengths of up to 30 m. Up to four cranes at a time lifted the trusses into place starting from the centre of the cathedral and working to each end. Five individual trusses in the centre support the weight of the three-section roof structure and act as the fulcrum for the wall sections. The superstructure contains about 1000 tonnes of steel.

More than 12 000 pieces of tempered, silver-plated glass cover the steel framework. The glass panels are assembled into panels of up to seven panes (or lights) each. Each window panel has adjustable aluminium "anchors" which are bolted to steel anchors welded on the superstructure's frame. In theory, the smaller, thicker panes of tempered glass in flexible mountings within the aluminium frames will let the cathedral withstand the effects of earthquakes and strong winds.

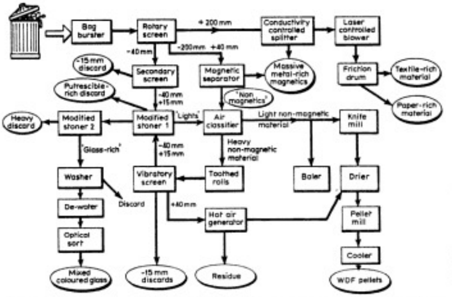
Electrical and plumbing installations are similar to those in ordinary buildings. Electrical wiring is routed through channels parallel to the truss members. Wiring for overhead lighting is passed through catwalks high above the cathedral floor from which lights are suspended. In daylight, the cathedral shines like a mirror when viewed from the outside. By night, its interior illumination will make it virtually transparent.

Work on the structure is slightly behind schedule and is costing more than its backers envisaged. Cost overruns are not a problem, however. The congregation is very ready to give to the building fund: on one Sunday in 1978, $1·42 million in cash was collected. □



Californians see the light: the cathedral's interior (bottom, left) includes triangular balconies for the congregation. Right one of the building's outside faces, showing the reflection of an existing church, also made from glass

Yorkshire lays waste to ideas about rubbish



The new rubbish plant will take 60 000 tonnes of refuse per year and extract useful materials. The figures in the flow chart refer to the diameters of the particles screened out

Doncaster's new rubbish sorting plant gives hope to people who think there is more to rubbish than throwing it away. The £2·7 million installation extracts valuable materials from household waste so that they can be sold to industry.

However, it will take as long as five years before the installation starts to earn more than the £440 000 per year it costs to run. The plant is operated by South Yorkshire District Council, which shared the costs of building it with the Department of the Environment.

The council says that next year the income from sales of materials will be £140 000. The following year the figure will be £250 000. After that the council hopes to start up a second refuse treatment line, which will double the plant's capacity by taking rubbish from industry as well as people's homes, but add only slightly to running costs.

Despite the length of time before the installation pays for itself, George Thomas, the council's chief environmental health officer, says that many other cities in the UK should investigate the idea of building their own plants. There are very few similar rubbish sorting systems in Britain. What is making them more attractive is the rising cost of carrying rubbish to dumping sites.

Based on a prototype built at the Department of Industry's Warren Spring Laboratory in Stevenage, the Doncaster plant sorts from rubbish a mixture of materials—ferrous metals, glass, paper, plastics and vegetable matter.

Ferrous metals are extracted by magnets and sold to scrap merchants for £15 per tonne. The plant's operators also produce pelletised fuel composed of low-grade paper and plastic. The waste-derived-fuel pellets have two-thirds the calorific value of coal; they will be burnt, mixed with coal, as cheap industrial fuel.

Large pieces of paper and plastic are sorted by a laser technique which detects how different materials reflect a beam of light and separates them accordingly. Paper will be sold to mills for repulping and making into cardboard. The future of the inevitably dirty and mixed plastics is less certain. But at least one chemical company is interested in making them into a weatherproof material for agricultural use.

The operators hit a snag in their ideas for selling broken glass. There is a lot of coal ash in the refuse and this makes it more difficult to clean the glass, once it has been separated, in the plant's washing process. However, with more powerful washing, the operators think there will be no difficulty in selling the glass at £15 per tonne to several neighbouring glassworks.

According to George Thomas, the refuse plant has three important features—it involves low technology, low labour costs, and low energy consumption. Except for the air classifier that separates paper from heavier refuse, and the laser system that sorts paper and plastics, all the equipment in the plant can be bought as standard items in most parts of the world. Five men per shift can run the plant. The energy cost of separation is kept to a minimum by keeping the larger bits of rubbish intact and not chopping the whole lot up before separation begins. ☐

Nuclear authority warms to home heating

France's atomic energy agency, the Commissariat à l'Energie Atomique (CEA), wants to build in Grenoble the first version of what it calls a Thermos urban heating reactor. The 100-megawatt light-water reactor has been under development for two years. It is designed to supply hot water rather than to drive turbines to generate electricity.

The CEA claims the reactor is both cheap and safe. Built mainly underground and with a special dome, the reactor should be safe from the effects of disasters such as plane crashes or earthquakes.

The agency believes that Grenoble is a logical trial site for Thermos—which France's safety authorities have yet to give a clean bill of health—because the city has about 70 kilometres of piping used by an existing oil-fired heating system. Moreover, the CEA's research work on Thermos was carried out at its centre in Grenoble.

A trial installation could lead to big overseas sales. A few years ago, the French talked about installing Thermos systems to heat up some of the colder parts of Siberia. Since then, there has been little sign of renewed efforts to sell the reactors, although the CEA says discussions are still continuing.

The CEA will not get the go-ahead for the site in Grenoble without a struggle. Local groups of environmentalists, reluctant to accept any kind of nuclear reactor, point to Grenoble's abundant supply of hydroelectric resources, coal deposits and surplus heat from a nearby chemical plant.

There are also some technical hurdles to be overcome. The existing pipe network is not entirely suitable for the Thermos reactor. Thermos will pump out water at 120°C, while the existing oil-fired network provides hot water at 130-180°C. Therefore the pipes might have to be modified. Boosting the performance of Thermos to produce water at higher temperatures would be a costly alternative. It would entail an increase in water pressure and new engineering techniques.

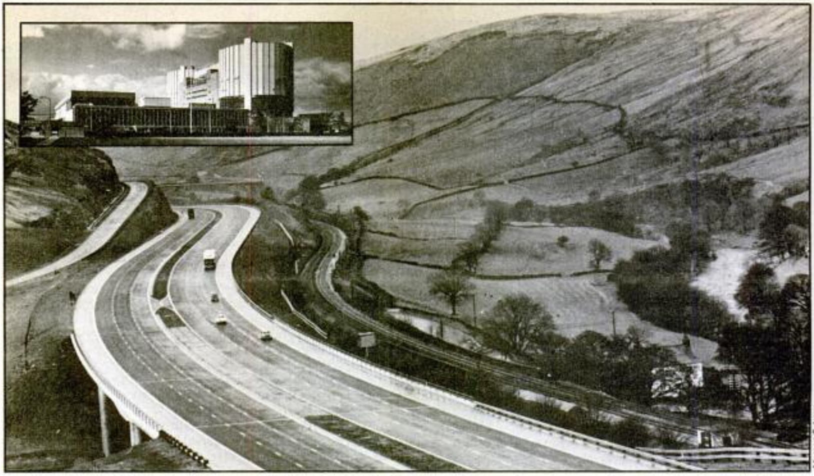
Opponents also claim that the government has not assessed the costs of the project stringently enough. However, the CEA says that the £20 million reactor should save 25 000 tonnes of fuel oil per year. ☐

White heat of technology

Milk drinkers in the state of Victoria in Australia can thank the Sun for the fact that their beverage is free from germs. A solar-powered pasteurising plant has started operation at the state's North Eastern Dairy Company. Every morning the installation heats 13 000 litres of milk to about 74°C: the milk remains at this temperature for 15 seconds before being cooled to 3·5°C. The £35 000 project is funded by the Victorian Solar Energy Research Committee, an organisation set up two years ago.

The installation draws heat from a 25 000 litre tank of water that has been warmed by 120 solar collecting panels of total area 190 sq.m. Steam from a boiler is available to provide extra heat if the Sun is not shining. The backers of the project say 55 to 60 per cent of the heat provided to the pasteuriser will come from the panels.

Cash for developing the plant has come from the Solar Energy Research Committee's £290 000 per year research budget. The organisation wants to start other projects which use solar technology—for instance in food canning factories or abattoirs. ☐



Homer Sykes

A motorway threat to nuclear democracy

When the House of Lords recently ruled firmly against objectors to the M40 and M42 motorways, it delivered a judgement that could have enormous implications for Britain's nuclear power programme

Robin Grove-White is assistant secretary to the Council for the Protection of Rural England

In Bushell and Another *v.* the Secretary of State for the Environment the Law Lords ruled that the inspector at the public inquiry into the two motorways at Bromsgrove in 1973-74 had been right to prohibit cross-examination of official witnesses on the government's methods of forecasting traffic requirements. The Lords made it clear that objectors' rights at public inquiries are much more limited than has been widely assumed in recent years.

Coming from the highest court in the land, these judgements will shape the role and conduct of participants in all future public inquiries.

The government is determined that more nuclear power stations shall be built. Energy Secretary David Howell's House of Commons statement on 18 December told the nuclear energy industries that they can now plan on the assumption that at least 15 000 megawatts of new nuclear capacity—say, 10 large reactors—will be ordered over the next 12 years.

The electricity supply industry could thus face 10 or more public inquiries into nuclear station proposals between 1982 and 1992. On the face of it, the Lords's rulings will make the industry's job easier. However, the very baldness of the judgement could have the reverse effect, by so upsetting public confidence in the inquiry process as to make nuclear expansion more difficult.

Even without the M42 judgements, the government's preferred timetable would strain Britain's long-established system of public inquiries. As the Council for the Protection of Rural England and Friends of the Earth emphasised in a recent letter to the Environment Secretary, Michael Heseltine, a succession of nuclear station inquiries can be expected at potential reactor sites around the country. Objectors at these—be they local authorities, local residents or national environmental bodies—will see the result of each inquiry as a foregone conclusion, as the government will already be committed to the construction programme of which the individual proposal forms part. In these circumstances, evidence and challenge on such questions as "need"—the staple diet of inquiries like those at Windscale and the Vale of Belvoir—will appear superfluous.

The M42 judgements carry matters still further. Applied to nuclear power stations, they mean that there is now no basis in law for challenge at a public inquiry to anything but the cosmetic aspects of a scheme.

Lord Diplock's judgement clarifies two particularly important points. First, he has ruled that no breach of natural justice is entailed if an inspector refuses to allow an objector to cross-examine an official expert witness at an inquiry (though, of course, the objector may comment on relevant matters in his own evidence). Second, he has made it clear that an inspector may prohibit challenge by objectors on general issues, *even if these are not matters of government policy.*

Such rulings may, or may not, declare new law. They certainly conflict with widespread expectations of public inquiries that have grown up in recent years. As the 1977 High Court judgement in Nicholson *v.* the Secretary of State for Energy noted: "It used to be commonly thought that the purpose of a local inquiry was to enable local residents and organisations to 'blow off steam', but that is no longer the case, for persons and bodies opposed to a project now expect to take an active, intelligent and informed part in the decision-making process. If that expectation is denied, a sense of grievance results and public opinion is affronted." The House of Lords has rejected this view of public inquiries.

What then will happen when new nuclear power stations are proposed? The Secretary of State for Energy has said he will hold an inquiry into the first proposal for a pressurised water reactor (PWR) after the Nuclear Installations Inspectorate (NII) has given safety clearance. But this inquiry, being the first, would perhaps be unrepresentative. A picture of the tensions to which a *succession* of nuclear power station orders could give rise is best gained from looking at the likely circumstances of the subsequent nuclear stations.

Consider the following sample of issues which are certain to arise at public inquiries:

- In the past, official forecasts of electricity demand have proved grossly incorrect. Similar errors could lead to proposals for superfluous power stations. Yet the M42 judgements mean that the methods underlying such forecasts will be immune from cross-examination by local authorities and other objectors.
- Safety standards and siting criteria for UK reactors are set by the NII. But as controversy grows in other countries—encouraged, perhaps, by further accidents like Three Mile Island—new criticism will be provoked in the UK. For example, the Rogovin report, a recent study for the US Nuclear Regulatory Commission, is reported to have recommended that future PWRs should not be sited within 25-40 miles of population centres. It is doubtful whether such a stringent criterion could always be satisfied in the United Kingdom. Yet however strongly objectors felt about the relevance of new evidence, like Rogovin, to a proposal for a PWR, they could be barred from cross-examining NII officials on the basic criteria for siting reactors in the UK.
- Where possible, the Central Electricity Generating Board (CEGB) likes to use existing nuclear power station sites for more than one station—as at Dungeness for example. Local authorities faced with applications to develop "greenfield" sites from the CEGB will be anxious to know whether further nuclear power stations—and 400 kV power transmission lines—will follow the first. But to establish this will require cross-examination of official witnesses on plans for nuclear expansion well into the future. The M42 judgements put such scrutiny outside the scope of public inquiries.

General confidence

Anyone with a nodding acquaintance of the 100-day Windscale or Vale of Belvoir inquiries can imagine dozens of similar examples. The strength of feelings likely to be aroused by proposals on nuclear power will make demands on public inquiries which the House of Lords has now ruled are without basis in law. The dangers of undermining general confidence in the processes of public inquiries need no elaboration.

This is a gloomy prognosis. Several arguments can be raised against it.

First, in the past, inspectors have not generally used their discretion to *restrict* the scope of public inquiries, particularly where the subject matter has been controversial. They have allowed discussion, and even cross-examination, on a wide range of issues, with the consent of the responsible government departments.

But the M42 judgements have now made plain the arbitrary basis on which such past indulgence has rested. What has been given can be taken away. The government's wholehearted commitments to nuclear expansion and the firm expectation of steady orders promised to the nuclear industry suggest that inspectors will be instructed to run future inquiries on a tight rein.

A second possible objection concerns the role of parliament. The Law Lords justified their restriction of the scope of local inquiries by claiming that a "wider forum" was more appropriate for the critical examination of issues such as forecasts and "need". The only independent forum that exists for consideration of such issues where energy policy is concerned is parliament's new Select Committee on Energy. There are no grounds at all for thinking that this committee could mount the kind of detailed critical scrutiny that will be needed. The Windscale and Belvoir inquiries show the problems. Parliament's processes can offer no convincing alternative to expert adversarial challenge by the bodies most aggrieved by particular proposals.

The third point is a related matter. David Howell assured the House of Commons on 18 December that there will be a public inquiry before the first PWR is built. This will be characterised by "the fullest explanations and the fullest discussion". He gave no hint as to the precise procedures that the inquiry will follow. Nevertheless, it might be argued that such a forum would clear the air on many of the most contentious safety and policy issues surrounding the PWR, thus permitting inquiries into subsequent PWR (or advanced gas-cooled reactor) proposals to be acceptably limited in scope.

This seems unduly optimistic. The history of motorway inquiries suggests that nuclear inquiries will grow in complexity as problems emerge and the fallibility of official judgements becomes clear. Local authorities harbouring prospective nuclear power station sites—such as Norfolk (Downham Market), Northumberland (Druridge Bay) and Gwent (Portskewett)—are anything but sanguine at the prospect of the CEGB's arrival. It may be more convincing to posit increasing rather than decreasing opposition, as successive proposals are brought forward. This is precisely what happened with motorways. It would intensify public expectations of inquiries.

Recent studies have urged the development of procedures to permit far greater public involvement in major energy decisions. Bodies such as the Town and Country Planning Association, the Outer Circle Policy Unit, the Council for Science and Society and the Political Ecology Research Group have suggested the development of elaborate two-tier inquiries for significant new developments. *Decision Making for Energy Futures*, an Aberdeen University report, has called for the creation of an Energy Policy Commission. But important as such suggestions have been, they have failed to address the dilemmas posed by the perpetual and dynamic interaction between nuclear expansion, the law and public expectations of due process.

Perhaps we should begin to face the possibility that there may be *no* way in which public involvement can be combined satisfactorily with nuclear expansion.

Nuclear power is acknowledged to be unique among energy sources in the scale of the industrial, political and capital commitments required to sustain and implement it. Mans Lonnroth and William Walker have shown in a recent important study, *The Viability of the Civil Nuclear Industry*, that the world's most successful nuclear programmes have been those of the USSR and France—countries with "centralised and relatively closed political systems, and with substantial state control over the utility and nuclear industries". There seems to be no coincidence here. Not only does a growing nuclear electricity system require the privileged access to capital that direct state involvement guarantees. It also needs a domestic political context in which disruptions to its plans and schedules can be minimised. Put simply, the French and Soviet experience seems to show that the fewer the avenues by which serious domestic nuclear opposition can emerge, the greater the likelihood that a nuclear programme can be successfully implemented.

Seen in this light, the combination of the M42 judgements and the government's nuclear intentions suggests a move toward planning methods more closed and autocratic than those to which we in the United Kingdom have hitherto been accustomed. ☐

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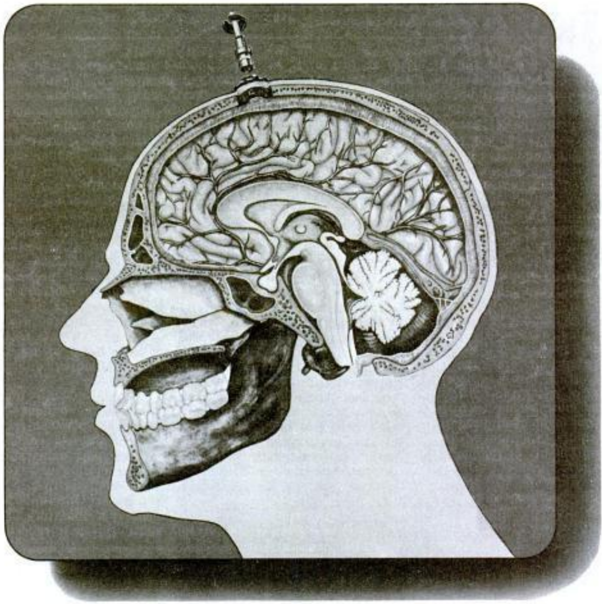

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Medical research. Research into therapeutic means of combating virus disease is being carried out at the Tokyo Metropolitan Institute of Medical Science with the aid of a Philips EM400 electron microscope. Utilising state-of-the-art electronics, the EM400's magnification factor of 800,000 is particularly suited to the study of 4 micro-sized infectious agents, such as viruses, that cannot be resolved in the light microscope. In addition to government health activities, the Institute's therapeutic research is contributing to those of the World Health Organisation as one of the centres for reference and research on viral hepatitis.

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Philips working on advanced technology

The age of the Universe

Astronomers believe they have good evidence that the age of the Universe—the time since the big bang—is between 10 and 20 thousand million years. How do they know this—and can these limits be narrowed down by new observations of distant galaxies?

Dr John Gribbin
has been talking to Dr David Hanes, of the Institute of Astronomy, University of Cambridge

Professional astronomers were excited, and the general public intrigued and perhaps mystified, by the announcement late last year that a remeasurement of the age of the Universe indicated it to be only half as old as had lately been believed (*New Scientist*, 22 November, p 587). Three young American astronomers—Marc Aaronson of Steward Observatory, John Huchra of Harvard University and Jeremy Mould of Kitt Peak National Observatory—had redetermined by a new technique the distances to several relatively nearby galaxies. They suggested as a result that the best estimate of the age of the Universe should lie close to 10 000 million years, rather than the 20 000 million years which has been increasingly accepted by the astronomical community over the past 20 years or so. To find out how simple measurements of the *distances* to galaxies are able to tell us about the age of the Universe, and why there should be disagreement over a factor of two in the results obtained by different techniques, I spoke to David Hanes, of the Institute of Astronomy in Cambridge. He too has been looking at the problem of measuring the distances to galaxies, and the implications for our understanding of the Universe at large.

Hanes stressed that animated and often heated discussions concerning just this range of age estimates, 10 to 20 thousand million years, have been going on for the past two decades, and that it was only in 1952 that astronomers settled even on this "ball park" of estimates. It was then that astronomers realised their established scale of cosmic distances was wrong not by a factor of two but by a factor of four. Virtually overnight the accepted "age of the Universe" at that time was quadrupled—a discovery which captured public attention to an unprecedented degree. It puts the current bout of excitement in perspective as an indication that, perhaps, astronomers are steadily getting better estimates of when the big bang really happened.

A factor of two is, in any event, nothing too extravagant when we are dealing in ages of thousands of millions of years. The difference between 10 and 20 thousand million is, indeed, a factor of two; but the difference between *one* year and 10 thousand million years is a factor of 10 thousand million! The "error" present in the age estimates is much less significant than the dramatic fact that astronomical observations are able to provide a clear indication that there was a definite beginning to the Universe, however many thousand million years ago it took place.

Recession velocities

The history of the concept of the expanding big bang Universe is remarkably short. As Hanes stresses, the most meaningful "age of the Universe" we have is the so-called "expansion age", and the discovery of the expansion of the Universe dates back only to 1912, when Vesto Slipher, working at the Lowell Observatory, first established that many non-stellar objects—nebulae—are receding from us at velocities of hundreds or thousands of kilometres per second. These are much greater than the measured doppler velocities of stars in our Milky Way. The recession velocities were measured from the doppler red shifts of features in the spectra of these nebulae, but the precise nature of the nebulae remained a mystery until 1924, when Edwin Hubble, using the then-new 100-inch telescope at Mount Wilson, detected individual Cepheid variable stars in some of them. He was able to prove beyond doubt that they lay beyond our Milky Way system and formed galaxies in their own right.

Hubble and Milton Humason were able to show over the next few years that the large recession velocities of the external galaxies are correlated with their apparent brightnesses—the fainter galaxies (which presumably look fainter only because they are further away) are receding more rapidly than brighter (nearby) galaxies. This correlation was confirmed and refined by measurements of Cepheid variables in the closer external galaxies—the Cepheids pulsate with a period related to their brightness, giving "standard candles" for making distance measurements over the range that individual Cepheid stars can be identified. The improving measurements soon showed that the relationship between velocity and distance is linear, and it is usually expressed algebraically in the form $V=H_0d$—the recession velocity V of a galaxy is proportional to its distance d. The constant of proportionality, H_0, is now known as the Hubble constant; Hubble himself used a "k" in the equation. This discovery, combined with the realisation that Einstein's equations could be interpreted as a description of an expanding universe, established cosmology as a science and made it possible, eventually, to describe how the Universe has evolved from an initial outburst (the big bang) to its present state (see *New Scientist*, vol 83, p 506).

Large-scale patterns

Leaving aside the cosmological subtleties, and looking just at what these discoveries tell us about the age of the Universe, it is important, first, to ignore the small-scale "peculiar motions" of individual galaxies which slightly disturb the pattern of universal expansion. The nearby Andromeda galaxy (M31), for example, is actually moving towards us. Secondly, Hubble's constant is not, strictly speaking, a constant at all, because the gravitational attraction of all the matter in the Universe must act to slow down the expansion of the galaxies away from one another. Hubble's "constant" should decrease with time as the expansion velocities of all the galaxies decrease with time, and this is why it is given the subscript zero, to imply the *present* value of what some scrupulously correct astronomers prefer to call the Hubble "ratio" or Hubble "parameter". But detectable changes in H_0 occur only over times vastly greater than any human timescale. The parameter, H_0, is expressed in units of km/s/Mpc, so that a galaxy at a distance of 1 Mpc (3·26 million light years, one megaparsec) is receding at a velocity of H_0 km/s, a galaxy at a distance of 2 Mpc has twice that recession velocity, and so on.

So we live in an expanding Universe. Using the helpful (but, he stresses, not strictly accurate) analogy of an exploding bomb, Hanes likens the outward rush of the galaxies to the outward rush of fragments from the bomb. The fastest moving fragments travel furthest in any given time, so that at some instant after the explosion the observed velocities of the fragments will be proportional to their distances from the site of the explosion, ignoring external factors such as air resistance. Such a "Hubble law" holds regardless of which fragment—which galaxy—

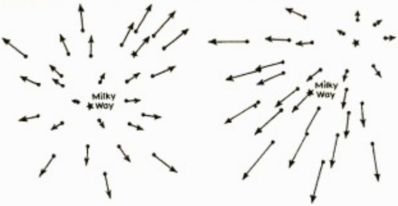

Figure 1 The expansion of the Universe seen from different galaxies always produces a Hubble velocity/distance relationship. (Based on Figure 22 in Modern Cosmology *by D. W. Sciama)*

is chosen as the reference point from which distances and velocities are measured, as Figure 1 shows.

From this analogy, it is easy to see a way of determining the age of the Universe. Simply divide the distance between any two galaxies—fragments—by their relative recession velocity, which gives the time since they were "touching", interpreted as the time since the big bang. The real Universe is decelerating, of course, so the relative recession velocity must have been bigger in the past, and this simple calculation must give an overestimate of the age of the Universe, the time since the big bang explosion. But a consistent overestimate would be enough to satisfy most cosmologists today. In terms of the Hubble constant, H_0, this estimate of the age of the Universe, dubbed the "expansion age" or the "Hubble time", is simply given by $t=d/V=1/H_0$

Although Hubble was well aware of these implications, and had a reliable tool for measuring velocities of galaxies in the form of the red shift, it was much harder to measure distances to other galaxies accurately. In addition, because the nearest galaxies have peculiar velocities which do not fit into the overall expansion pattern, estimates of the expansion age depend on measuring, as accurately as possible, the distances to galaxies at least tens of millions of light years away. For half a century, the distance estimates have been the weak link in the chain, and it is changes in the distance scale which have led to sometimes dramatic changes in our best estimates of the age of the Universe. Hubble and Humason, pioneers in this work, came up with an estimate of 2 thousand million years for the expansion age, embarrassingly short as geological studies already indicated at that time a much older age for the Earth, and nobody was happy with the idea that the Universe might be younger than our planet! The dilemma was resolved in 1952, when it was discovered, with the aid of ever improving observations, that Hubble had in some cases mistaken one kind of variable star for another and that in some remote galaxies superbright clouds of ionised gas had been mis-identified as stars. The result was the four-fold increase in estimates of the extragalactic distance scale which pushed back the expansion age to 8000 million years, comfortably longer than the age of the Solar System (estimated at around 4½ thousand million years from various pieces of evidence). Since then, further improvements of the cosmic distance scale have tended to push estimates of the expansion age up towards 20 thousand million years—a trend now reversed by the work of Aaronson, Huchra and Mould, and the completely independent studies made by Hanes, using a relatively unsung, but equally impressive, new technique.

Hanes has tackled the problem by studying the brightness of globular clusters of stars in distant galaxies. These clusters are, potentially, excellent cosmic distance indicators, not least because they contain very many stars and are therefore very bright, visible over great distances across the Universe. As the name implies, globular clusters are spherical; they may contain up to a million stars in one cluster, with the average brightness of each star comparable with the brightness of our Sun. More than a hundred such clusters are visible around our own Galaxy, and they can be identified in their thousands around galaxies in the Virgo cluster, tens of millions of light years away (Figure 2). If only all globular clusters were exactly the same brightness, intergalactic distances could be determined simply by measuring their apparent brightnesses, which would be dimmed simply in line with the inverse square law, which says that a "standard candle" at a distance $2x$ from us will appear one quarter as bright as an identical standard candle at a distance of x. Unfortunately, as Figure 3 shows, globular clusters are not all identical. Within our own Galaxy, the brightest globular cluster is more than 100 times as luminous as the faintest one known, and a simple-minded comparison of two globular clusters chosen at random in different galaxies could give hopelessly misleading indications of the relative distances of the two galaxies from us.

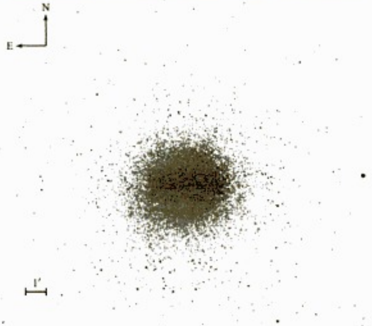

Figure 2 A globular cluster in our Galaxy, resolved into individual stars; galaxies in the Virgo Cluster, are surrounded by thousands of globular clusters which cannot be resolved into separate stars

But Hanes has found, from a painstaking study of the globular clusters associated with 20 galaxies in the Virgo cluster, that the relative numbers of bright and faint globular clusters in each galaxy follow the same pattern. When the numbers of clusters at each brightness are plotted graphically, as a "luminosity function", essentially identical curves are obtained for galaxies which are known, from their physical association with one another in a group, to be at roughly the same distance from us. When this discovery is applied to studies of the luminosity function of a randomly chosen galaxy's family of globular clusters, it gives an unambiguous indication of distance.

First, Hanes takes the luminosity function for the globulars in our own Galaxy; then, he takes the luminosity function for the globulars in the galaxy being studied, and the two plots are compared. Because of the dimming of the light from the distant galaxy by the inverse square law, the two luminosity functions do not look identical in their "raw" state. But, by modifying the function which corresponds to the globulars in our Galaxy by an appropriate inverse square diminution the two curves can be made to coincide exactly. The unique distance that corresponds to the luminosity adjustment required gives the

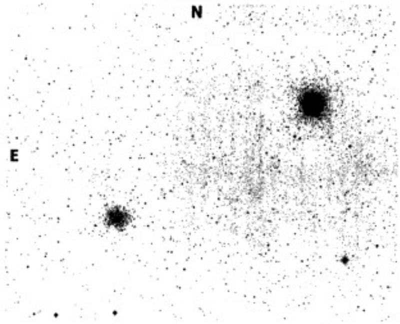

Figure 3 Two globular clusters in our Galaxy. These are both at roughly the same distance from us, so the difference in brightness apparent in the photograph is real

distance to the other galaxy (Figure 4). Astronomers measure the brightness of celestial objects in "magnitudes", so that a distance determined in this way is given in magnitudes as a "distance modulus". Using the Virgo cluster data, Hanes comes up with a distance modulus of 30·7 mag, corresponding to an expansion age of the Universe of 12·5 thousand million years, and a Hubble constant of 80 km/s/Mpc (10 thousand million years corresponds to $H_0 = 100$ km/s/Mpc; 20 thousand million years to $H_0 = 50$ km/s/Mpc). These results were published last year in the *Monthly Notices of the Royal Astronomical Society* (vol 188, p 901); other techniques, including a mass of evidence collected and analysed by Allan Sandage and Gustav Tammann, at the Hale Observatories, still point to an age of around 20 thousand million years, while a minority of other tests give results closer to Hanes's estimate. Although the larger expansion age is the value most widely quoted, there is certainly no consensus among astronomers today; Hanes merely says that "each method has its own merits and problems, and its own adherents and detractors". However, to an outsider looking in on the debate, one thing is clear—whereas the "standard" methods used by Sandage, Tammann and others depend on putting several (or many) pieces of evidence together, the globular cluster method uses just one type of observation of one class of astronomical objects. There is intrinsically less room for error in such a method, because the longer a chain of reasoning is the greater is the probability that it contains a weak link. Aaronson, Huchra and Mould have also used a one-step technique, but one which enables them to probe further out into the Universe, beyond the distance at which individual globular clusters can be picked out (although even their technique does not cover a truly large volume of space in terms of the whole of the visible Universe; distances to the most remote galaxies can be determined *only* by measuring red shifts and using the best estimate of H_0 in the Hubble velocity/distance relation).

Basically, their technique depends on a very simple fact: more massive galaxies contain more stars and are therefore brighter than their less massive brethren. If the *mass* of a galaxy can be determined, and we know the average brightness of a star, then we can estimate its absolute luminosity and determine its distance from its apparent luminosity and the familiar inverse square law. The mass is estimated by measuring the rate at which the chosen galaxy is rotating, because more massive systems must rotate more rapidly to prevent them collapsing under their own gravitational pull. For flattened galaxies seen edge on, it is a straightforward matter to measure rotation because the doppler shifts in spectra taken at the two extremities of the galaxy give a direct indication of how fast one side is moving towards us and the other is moving away (assuming, of course, that the overall red shift caused by the expansion of the Universe is subtracted out). As galaxies are rich in neutral hydrogen gas, Aaronson, Huchra and Mould actually use the 21-cm radiation of this gas to measure the rotation rates, rather than using optical spectra, but the principle is the same.

So far so good—but it is still necessary to measure the luminosities, and this causes problems. Brent Tully and Richard Fisher, who pioneered the technique, originally measured the luminosities in blue light, but these short wavelengths are easily scattered by dust grains (exactly as blue light is scattered by dust in the atmosphere, leaving a red sunset), and as dust concentrates in the plane of a galaxy, this scattering is particularly important for light coming from galaxies viewed edge on. If face-on galaxies are studied to reduce this difficulty, it is much harder to measure the rotation rates—direct monitoring of the rotation would need observations over thousands of years, because a galaxy like our own takes hundreds of millions of years to turn once. So first attempts to use the Tully-Fisher technique came up with very different results depending on just what assumptions were made about absorption, and how big a correction was applied for inclination effects.

Now, Aaronson, Huchra and Mould (AHM) have attempted to overcome these difficulties by measuring brightnesses at infrared wavelengths, where the light penetrates dust more easily. This has the bonus that most of the mass of a galaxy is in the form of cool, red low-luminosity stars, so that infrared observations are close to the waveband where the dominant mass is most visible (all this discussion applies to the visible, bright galaxies,

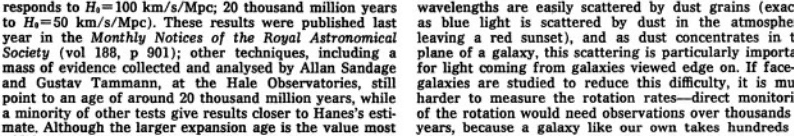

Figure 4 Comparisons of the luminosity function for globular clusters in five Virgo galaxies (boxes) and in our own Galaxy (dots), with corrections appropriate for shifting our Galaxy's clusters to different distance moduli. The sensitivity of this technique as a distance indicator is clearly indicated; in fact, the best fit of all is obtained for a distance modulus of 30·7 magnitudes

of course; there is a growing weight of evidence that much more mass may lie outside the bright region as dark matter—*New Scientist*, 8 November, p 436). Calibrating their measurements by studying first a few nearby galaxies whose distances are determined very accurately from measurements of Cepheid variables, the AHM team then turned its attention outwards, coming up with the surprises that made headlines late in 1979.

Hanes at least wasn't surprised by the results of the AHM study of the Virgo cluster—a relatively near neighbour on a truly universal scale—as the measurements indicated a distance to that cluster only 14 per cent greater than the distance determined from the globular cluster method, agreement well within the uncertainties of the two techniques. But because the AHM technique uses the light of whole galaxies, compared with Hanes's use of the light from clusters within galaxies, it can probe further out still, where it reveals that the Hubble constant determined from the Virgo studies is smaller than the Hubble constant measured for more distant galaxies. It is this discovery, rather than the low expansion age implied overall, that has caused most interest "in the trade", among astronomers. Several other measurements have indicated that our own Galaxy and its immediate neighbours may be falling towards the Virgo cluster at several hundred kilometres per second (see *New Scientist*, 31 January, p 317), and it looks increasingly as if our Galaxy has such a large "peculiar motion" that accurate measurements of the age of the Universe and conclusions about its evolution will require long-scale mapping over much greater distances than those used so far.

The expansion age derived by AHM is just over 10 thousand million years, which is on the edge of being uncomfortably short. Our best theoretical models of stellar evolution suggest that the stars in globular clusters, the oldest known stars, are just about this old, and perhaps even older. Hanes suggests that it is possible that a basic rethink of stellar evolution may yet be required if more evidence of such a short expansion age comes in. However, that time has not yet come, and until there is a much narrower spread between the estimates derived by different techniques (the Sandage-Tammann estimate of 20 thousand million years still has its adherents) none can be taken as gospel.

A completely independent, and in principle unambiguous, measure of the age of the Universe comes from studies of the decay products of radioactive isotopes found in old material, such as meteorites. As yet, however, the uncertainties involved in the practical application of this technique mean that the corresponding best estimate of the age of the Universe is between 13 and 22 thousand million years (*New Scientist*, 7 February, p 398). This might suggest that the AHM estimate is rather low, but there is too big a spread to resolve the broad conflict between the AHM and Hanes results and those of Sandage, Tammann and their colleagues.

The simplicity of both AHM and the Hanes study suggests that they should contain few errors, and the agreement between the two simple techniques is reassuring. The most fascinating question thrown up by all this work, though, is: just how far out into the Universe do we have to go before truly universal effects completely dominate over such "local" behaviour as the movement of our galaxy, at hundreds of kilometres per second, toward a "neighbour" such as the Virgo cluster, about 30 million light years away? ☐

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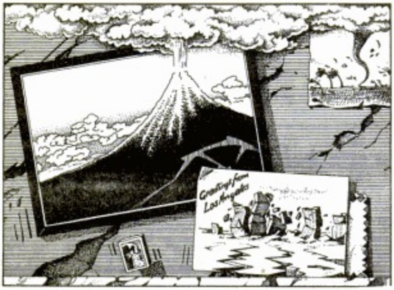
Review

You cataracts and hurricanoes . . .

Disasters

by John Whittow

Allen Lane, pp 411, £8·95



Ingram Pinn

There has been a dramatic increase in public awareness and concern regarding the environmental hazards to which mankind is constantly exposed. Innumerable words have been devoted to this topic and disaster has become a popular theme for horror films and paperback novels. A notable feature of this explosion of interest has been the growing realisation that we are ourselves largely responsible for many of the problems that arise, and a slow acceptance that some changes to our thoughtless and selfish way of life will be necessary if we are to preserve the unique natural environment of our planet for future generations.

Great displays of natural violence — volcanic eruptions, earthquakes, storms, floods or the impact of large meteorites —are not *disasters*, as such, unless living creatures and, in particular, man and his works, are destroyed, maimed or killed by them. Potential major disaster areas are those in which the population density is highest. The great earthquake of 27 July, 1976 at Tangshan in the People's Republic of China in which over 600 000 people died was a catastrophe only because so many people live in that particular part of Asia: when a much more powerful earthquake occurred in Assam on 15 August, 1950 the casualty list did not reach 2000!

Disasters are of three main kinds: entirely *man-made*, as in many road accidents or when a badly designed building collapses; *quasi-natural*, when our interference with, pollution of, or failure to understand natural systems precipitates disaster, or *natural*, as, for example, when a volcanic eruption overwhelms a city or when a hurricane veers across a developed coastline. Is there a need for yet another disaster book? The answer is *yes* because the field is so vast and so much still needs to be said and done. We have to identify, classify and understand all short- and long-term hazards, assess the risks involved, make social evaluations, develop methods of disaster prediction and control and coordinate our presently largely uncoordinated efforts.

John Whittow has produced a very readable, concise account of the most immediate environmental hazards facing mankind. The photographs used to illustrate his book are superb and most of the line drawings live up to this high standard. As a professional geographer, an expert on landform evolution and scenery with wide experience in Africa, Australia and America as well as the British Isles, he writes clearly and most convincingly on those aspects of the environment with which he is familiar. I like in particular his chapters on landslides and avalanches, ground surface collapse, storms, flood, drought, snow and fog. His first-hand account of Los Angeles as "hazard city" is excellent.

Unfortunately his geological knowledge, on the other hand, is less comprehensive and not always strictly correct. Thus the chapters on volcanic and earthquake disaster are less satisfactory than those that follow. It is regrettable, but understandable, for example, that he should confuse the volcanoes *Soufrière of Guadeloupe* and *Soufrière of St Vincent*. More serious is his uncritical acceptance of the erroneous descriptions of the volcanic activity and bad "expert" advice given to the civil authorities of Guadeloupe during the 1976 eruption and to the Icelandic authorities during the eruption on Heimaey in 1973.

The final chapter thoughtfully reviews the progress, weaknesses and failures of current disaster research. It deserves a wide audience.

Frank Fitch

Brain, behaviour and evolution

edited by D. Oakley and H. Plotkin

Philosophical problems in psychology

edited by N. Bolton

Methuen, pp 237 and 207, £9 and £8·50

Nearly half of undergraduate courses are now for "joint honours". The courses look attractive on paper but many prospective students are doomed to disappointment. "Disjointed honours" usually turns out to be the more accurate description. The problems faced by university departments in trying to cross traditional subject boundaries is compounded by a lack of suitably simple books. Serried ranks of single subject primers greet the student in library and bookshop alike. It is therefore especially good to see two new books in the "Psychology in Progress" series attempting to fill this gap for the behavioural sciences.

Brain, Behaviour and Evolution is a valiant attempt to link evolutionary theory with neurophysiology and psychology—and it is largely successful. The first three chapters are devoted to explaining in simple terms the theory behind genetics (with particular reference to behaviour), evolution (with particular reference to the brain) and behaviour (with particular emphasis on the brain and evolution). The following six chapters take single functions such as sleep, learning and symmetry/asymmetry in the brain and, in the words of the editors, look at them "as examples of adaptive behaviours whose significance can best be evaluated in relation to similar phenomena in other animals". Some of them succeed in doing just that. In the section on sleep, Ray Meddis bravely dumps the recuperative, psychoanalytic and memory consolidation type theories of function and argues (convincingly) that even reptiles dream. From this standpoint sleep becomes "a mechanism . . . to schedule activity and promote periods of immobility where appropriate". The different types of sleep simply reflect different stages of immobility. The other chapters take this argument into the traditionally human activities such as learning and speech. The discussions are backed up by useful lists of references.

In the most important sense the book magnificently fulfils its aims—for, if evolutionary theory is to be believed, then the arguments presented here become almost unanswerable and you are left wondering why the evolutionary approach isn't the main part of any study of behaviour.

Given this success it seems even more of a shame that the emphasis is placed heavily on learning to the detriment of other interesting areas. Perception—which is missed out altogether—is a gift to the evolutionary behaviourist. There must be more comparative data there than in almost any other psychological subject and this book would have been an ideal place to bring some of these together.

The second book, *Philosophical Problems in Psychology* approaches behaviour from a diametrically opposite perspective, and it is almost as revealing. Action, it argues, is dictated by intention. You cannot look at behaviour without taking the thought behind it into account. Like the first book, the chapters are written by individual experts but in this case the boundaries between their arguments are less clearly defined—there are two opposing viewpoints on the use of computer simulations for instance.

The book is divided into three sections: "Reason and action", "The psychology of action" and "The context of action". The first two look at how intention and action interrelate and how they may be modelled. The last goes into the individual. It is fashionable to think of behaviour in terms of the constructs we make about reality and this section was a particularly good introduction to that way of thinking, suggesting solutions to some of the problems implicit in the proliferation of approaches to psychotherapy.

The emphasis on action unfortunately precludes any real discussion of other areas of behaviour—again while the book succeeds in showing how philosophy can be useful in the study of behaviour it does not spread its net widely enough. This time learning could have been included and would perhaps have been of more direct relevance to most students of psychology.

Crossing traditional subject boundaries is hard enough even for the seasoned researcher. For the student, without the basic grounding in either discipline it must seem even more daunting. The message from these books is that perspectives can be combined and presented reasonably simply and, despite what they miss out, both texts would prove valuable to any student of the behavioural sciences. Indeed, if the combined courses are to succeed there should be a lot more like them on the market. **Tessa Livingstone**

Introduction to marine pollution control

by Jerome Williams

Wiley, pp 173, £14·70

Yet another book on this popular subject which the publisher's blurb describes as an "introductory resource" which takes "a holistic approach to coping with marine pollution". Although the introduction states that pollution is a biological problem, and the preface indicates that its study should be interdisciplinary, the book deals primarily with the limitation of physical and chemical processes as "an approach to maintaining low concentration levels".

Scene setting takes up the first 141 pages, dealing with technical aspects of pollution —what it is, where it comes from and where it goes in the marine environment. More space than would seem necessary in this slim volume is given up to the derivation of equations and simple predictive models dealing with diffusive processes and other factors involved in dispersing pollutants. Very few pages in this section are concerned with the control of pollution, but what information there is can be found by searching the last 15 pages of the text amongst the cost-benefit graphs and risk tables. It is certainly too late to leave the definitions of "standard", "criterion", "guideline" and "goal" to the penultimate page of the book.

BP

BP's Vikoma Seaskimmer

The theme seems to be that anything could be engineered out of the system. However, the reader is informed that he is living in an unreal world if he thinks the marine environment can be maintained in an unspoiled state and that many complaints about aesthetic pollution come from individuals who would rather live in the primeval environment not realising that it would not be available to them unless the commercial world about them supported it!

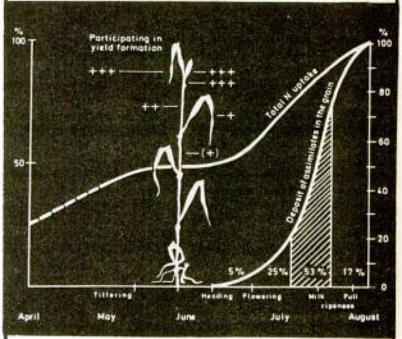
This book is concise rather than precise. Many sections are so brief that the treatment of topical, if not important, subjects such as oil, pesticides and radioactivity are almost cursory. In addition, references to a further treatment of the subjects elsewhere are so sparse that the reader is not really led into the subject area. It is claimed that in this book "an attempt has been made to cover all bets"—this is perhaps where the author and editors went astray.

Roger Mitchell

How to Obtain Abundant Clean Energy

by **Linda Baine McGown,** California State University, Long Beach
and **John O'M. Bockris,** Texas A&M University

Explaining why industrialized society's dependence on non-renewable energy sources can only lead to disaster, the authors of this crucial volume discuss in a clear and objective fashion what energy actually is, where we get it now, why present sources won't work for the future, and what alternatives are available. approx. 225 pp., illus., 1980, $14.95 ($17.94/£9.42 outside US)



Plant Regulation and World Agriculture

edited by **Tom K. Scott,** University of North Carolina, Chapel Hill

This volume applies current knowledge of the regulation of plant growth to enhancement of the world's yield of food, forage, fiber, and other useful plants. Topics covered include physiological processes; naturally occurring and synthetic plant growth regulators; plant breeding and genetics; and tissue culture and its use in the improvement of plant varieties. *NATO Advanced Study Institutes Series: Series A: Life Sciences, Volume 22.* 588 pp., 1979, $47.50 ($57.00/£29.93 outside US)

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North-South: a programme for survival

Independent Commission on International Development Issues (Brandt Commission)

Pan, pp 304, £1·95

The slenderish, easy-to-read paperback form of this book, from a publisher of broad appeal, underlines its all-embracing message, which has already travelled round the world long before its official release date. The Brandt commission report urges that there must be an immediate transfer of money on a large scale, either through normal aid channels or through international lending institutions such as the World Bank. And this is only one part of a four point emergency action programme for 1980-85 envisaged by the commission, which calls in addition for an international energy strategy, a global food programme and a start on reforming international systems to achieve a more equitable distribution of wealth.

Peter Mitchell/Camera Press

Brandt in relaxed pose

The reader may be forgiven for the thought "but I've heard this all before". What makes this message compelling is the stature of the commission—an independent group of 18 top-level politicians and economists, spearheaded by Willy Brandt, former West German Chancellor and winner of the 1971 Nobel Peace Prize. The group includes Britain's former prime minister, Edward Heath, Shridath Ramphal, the Guyanese Commonwealth Secretary-General, Adam Malik, past president of the UN General Assembly, and Joe Morris, the Canadian chairman of the International Labour Organisation.

Each member was invited to participate in his or her private capacity. Nevertheless, delegate selection in the end reflected the *realpolitik* of the world. The developed world was represented by the US, West Germany, Britain and France (major aid givers); the "middle developing" world by Kuwait, India, Indonesia and Malaysia; and the poorer Third World by Chile, Tanzania, Colombia, Upper Volta and Guyana; countries that are nevertheless politically very important. The most notable absence was that of the Soviet Union and its satellites, which were not invited to attend. (The report was circulated to most socialist leaders before publication, however.)

The group not only recommends an emergency action programme, but sets longer-term priorities for the next two decades, including reform of the world's monetary system and new ways of financing development. For example, the commission suggests setting up a new international currency to replace national currencies as international reserves. This currency would have special drawing rights to make available an unconditional source of funds to the Third World.

But in the meantime, the report recommends an immediate influx of hard cash by stepping up the timetable of developed countries' progress towards the United Nations' aid goal of 0·7 per cent of GNP by 1985. And it sets a new target of one per cent by 1990. These actions, the report says, should raise an additional sum of $50-$60 billion each year for Third World development by 1985.

Science and technology are not given much special attention in the report. For example, the UN's Conference on Science and Technology for Development is mentioned only in passing. This is pardonable as it directed its fire at transforming the "international economic order". But the commission does emphasise the importance of reaching UNCSTD's goal of spending 20 per cent of the world's R&D budget in the Third World by the year 2000. (At present 3 per cent is spent in the developing world.)

What makes this readable report particularly timely is that the worldwide recession is forcing the developed world to recognise its dependence on the Third World not only for raw materials but also for markets. The US, for example, exports more to the Third World than to the European Community. But will anybody listen? The report has been greeted in the US by government indifference (a contrast to its warm reception in Europe).

The pitfalls of the report are obvious: the emphasis on long-term institutional reform which might not happen quickly enough; a fuzzing of the roles of another potentially huge source of funding—the multinational corporations; and above all, its dependence on the political good will of rich and poor member countries to achieve such mighty goals.

At a recent press briefing, a spokesman for the commission emphasised the importance attached to the proposed summit meeting of world leaders planned for sometime later this year. But otherwise, he said, there are no concrete plans for a "son of Brandt" because the commission is most anxious not to be self-perpetuating. Unfortunately, this lack of follow up may be its biggest downfall.

Stephanie Yanchinski

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The biology of parasitism by Philip J. Whitfield (Edward Arnold, pp 277, £7·95) adopts a contemporary approach designed to increase the student's understanding of association biology, and promotes the premise that it is more realistic to accept the variable phenomenon concept of parasitism. Associations between organisms have therefore been considered in less rigid terms than have hitherto prevailed, so words like "phoresis" and "inquilism" have not found favour with this author, though he has provided working definitions of parasitism, commensalism and symbiosis.

The adoption of experimentalist headings like "nutrient exchanges", "regulatory interactions" and "behavioural aspects" have enabled Whitfield to avoid a traditional taxonomic textual arrangement while still drawing on a wide range of organisms to illustrate recent work on topics like immunology, sensory mechanisms and structural relationships. Such an arrangement in a short book like this means that taxonomic coverage cannot be total and in order to benefit, readers must have an adequate background.

Certainly this text, with its 385 up-to-date references, informative diagrams and photographs, brings a breath of fresh air to the teaching of undergraduate parasitology, but it is best regarded as a contribution to the course literature which must be preceeded by an adequate foundation in taxonomy and morphology.

Peter J. Baron

Heritage

The challenge of the chip

Science Museum

By the time this exhibition closes in 1981—a year which no doubt will be marked by nationwide street parties and other festivities foisted upon us to celebrate the 10th anniversary of the microprocessor's invention—I wonder what exactly the event will have achieved. Will it lead to a sharpening of awareness of the issues thrown up by the encroachment of electronics into more and more areas of life? Or will the effects of the exhibition be lost in the general haze about microelectronics caused by the razzmatazz of media attention? I think the latter is more likely.

The exhibition has little new to offer about either integrated circuits or their applications. That, by itself, is not a fault. However, it does a poor job of explaining what microelectronics is all about to a (presumably) uninformed audience—and this is a failing. I was confused by the displays in the early part of the exhibition which should have set out facts clearly and succinctly for those who are interested enough to learn them. Instead, there are some attempts to convey what silicon is, how electronics is being used in increasing numbers of products and so on.

(There is also a good collection of toys controlled by microprocessors that I expect people will have fun playing with. I predict, however, that the microprocessor-operated electric train set will not last long: this is as easy to wreck by over-exuberant use of the controls as the train sets of the pre-electronic era.)

Anyone who enters the museum not knowing the differences between microprocessors, integrated circuits, semiconductors, or any other technical-sounding words that he or she may have stumbled across, is unlikely to discover the answers here.

The exhibition is divided into two sections: the first aims to provide explanations of the technology, and the second (organised by the Design Council) presents applications of the "new" electronics already under development by organisations such as the Post Office and Marconi Avionics. The second part is the more interesting. On show are a number of electronically-aided appliances that are likely to feature in everyone's homes and offices.

But whoever organised the telecommunications part of the exhibition committed a real gaffe by asking the Post Office to submit a film about its new computer-controlled telephone network, System X. The film is narrated by a man with a funny voice who is supposed to be the Post Office's lovable "mascot" Buzby—and is embarrassingly awful.

The exhibition is full of these "audio-visuals" in which voices blare out from televisions. Such ways of presenting information have presumably caught on because of the belief that people cannot understand anything that does not emanate from a TV. However, the method breaks down when there are so many audio-visuals that they drown each other. In one part of the exhibition there are five TV voices all in competition, leaving the visitor with the impression he has stumbled into an electronic Tower of Babel.

By far the best exhibit is that by the Department of Industry which explains, with the help of some gentle humour provided by pleasant cartoons, the differences between machines controlled by microprocessors and other types of electrical equipment. Significantly, there isn't an audio-visual within earshot.

Peter Marsh

Audience

Thee and me

National Theatre

Phillip Martin wrote that extraordinary TV series *Gangsters*, but this, the first of his stage plays to reach London, is not so successful.

Man's tampering has destroyed the ozone layer, and much of Britain has become a desert. Most of the surviving population live under a regimented state, the control of water having led to the control of everything else. A few hardy individualists live outside the pale, though most of their springs are drying out in the unremitting drought. Jack Gromer, a patriarchal figure with a Birmingham accent has led his family into the wilderness, and miraculously found a spring. There they live in a pyramid of water-pipe sections, and are lapsing into the enactment of primitive authoritarian religious rites.

Jack's son, Will, is married off to breed grandsons, which merely adds to his resentment of life in general. Then a stranger, like an asbestos-clad spaceman appears. He claims he too is a rebel, but is suspected of really wanting to annex their water supply for the state. He starts teaching Will the now-useless art of reading, and that contrary to his father's indoctrination, the state is a Good Thing: the need to utilise every drop of water has led to a true communism—people care for each other. Will ends unconvinced, but does realise that his father has been brain-washing him at least as effectively as the state would.

This is a strong plot, strongly told and strongly staged. But there is a great weakness: plays achieve their impact through dialogue, and it is extremely difficult to create a good play around inarticulate characters. Film can substitute the frequent shift of scene or change of focus for words, but the theatre cannot. In a way, the play would have been stronger if the mechanics of its basic conflict had been worked out inside the state rather than the wilderness. Then, too, the expository scene where the reason for the climatic debacle was explained would not have stood out like a sore thumb—one would expect lots of glib educationalists in the state.

Martin Goldman

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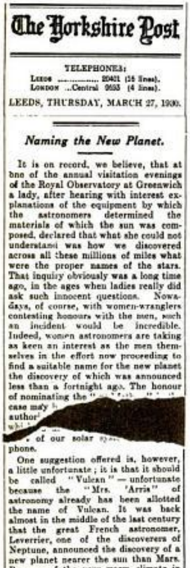
Heritage

God of the underworld

On March 14, 1930, the International Astronomical Union's Circular No 255 contained the following telegram under the heading of "Transneptunian planet?"

> "Lowell observatory telegraphs systematic search begun years ago supplementing Lowell's investigations for transneptunian planet has revealed object which for seven weeks has in rate of motion and path consistently conformed to transneptunian body at approximate distance he assigned fifteenth magnitude position march twelve three hours GMT was seven seconds of time west from delta geminorum agreeing with Lowell's predicted longitude *Shapley*."

This was the third planet to have been discovered since antiquity, following the first observation of Uranus in 1781 (about 2870 million km away from the Sun) and Neptune in 1846 (at a distance of 4497 million km). The quest for Pluto, about 5900 million km from the Sun, was by far the most laborious. Since the discovery of Neptune, astronomers had attempted to detect the presence of an exterior planet by examining small differences between theoretical and observed positions of the outer planets. Neptune's existence accounted for about 98 per cent of the deviation of Uranus from its predicted orbit. Perturbations in longitude were the easiest to find—longitude being a planet's position around its orbit.



The Yorkshire Post

TELEPHONES:
LEEDS .... 20401 (25 lines).
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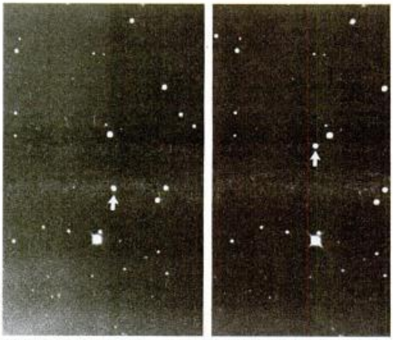
LEEDS, THURSDAY, MARCH 27, 1930.

Naming the New Planet.

It is on record, we believe, that at one of the annual visitation evenings of the Royal Observatory at Greenwich a lady, after hearing with interest explanations of the equipment by which the astronomers determined the materials of which the sun was composed, declared that what she could not understand was how we discovered across all these millions of miles what were the proper names of the stars. That inquiry obviously was a long time ago, in the ages when ladies really did ask such innocent questions. Nowadays, of course, with women-wranglers contesting honours with the men, such an incident would be incredible. Indeed, women astronomers are taking as keen an interest as the men themselves in the effort now proceeding to find a suitable name for the new planet the discovery of which was announced less than a fortnight ago. The honour of nominating the " [illegible]
case may b[illegible]
author[illegible]
whi[illegible]
[illegible] of our solar sys[illegible]
phone.

One suggestion offered is, however, a little unfortunate; it is that it should be called "Vulcan" — unfortunate because the "Mrs. 'Arris" of astronomy already has been allotted the name of Vulcan. It was back almost in the middle of the last century that the great French astronomer, Leverrier, one of the discoverers of Neptune, announced the discovery of a new planet nearer the sun than Mars. Because of the very warm climate in which a planet so situated must exist—and perhaps it occurred to the Frenchman's mind that the neighbourhood of Mars and Venus would be appropriate—it was named Vulcan. But Vulcan

The discovery aroused great interest throughout the country



Pluto (arrowed) can only be distinguished from its background of stars by the change in its position over a few days

Simon Mitton

The two most successful predictions for Pluto's orbit were those of Percival Lowell (who caused much controversy and commotion with his suggestion that the so-called canals of Mars indicated the presence of life on the planet) in 1915 and William Pickering in 1919. Both tried to estimate the mass and orbit of the unknown planet which would give the observed perturbations in Neptune's orbit. Their results were in good agreement, each having the orbital parameters almost right, but the mass wrong by a factor of 1000. However, Pickering's estimate of Pluto's brightness was closer than Lowell's.

Lowell was convinced that the ninth planet should, during the 1900s, appear in the constellation of Gemini and he searched the skies in this region using the telescope at his observatory in Arizona. His quest was unsuccessful and he died in November 1916 a disappointed man.

The search for the ninth planet continued after Lowell's death but it was not helped by his underestimate of the planet's brightness. In 1929 Lawrence Lowell (Percival's brother) presented a wide-angle telescope-camera to the observatory. The strategy was to photograph the same portion of the sky on two separate occasions and then to compare the plates to see if anything had moved. Unfortunately Gemini appears in the sky near the Milky Way and each plate contained thousands upon thousands of star images. They were therefore analysed using a blink microscope. This device enables the observer to shift his vision rapidly from one plate to the other. If the plates are properly aligned the images of stars remain stationary. A moving object such as a planet, asteroid or comet will, however, appear to jump back and forth.

Clyde Tombaugh, an assistant at the Lowell observatory discovered the ninth planet. He wrote:

> ". . . when one-fourth of the way through this pair of plates (centered on delta Geminorum), on the afternoon of February 18, 1930, I suddenly came upon the images of Pluto! The experience was an intense thrill, because the nature of the object was apparent at first sight. . . . In all of the two million stars examined thus far, nothing had been found that was as promising as this object. . . . The images were quickly found on both plates on January 21, the position conforming with the motion indicated by the plates of January 23, and 29. Thereupon, I informed the Director and other members of the staff, who came to take a look."

The discovery was checked by looking at later photographs and then the telegram announcing the discovery was sent out on 13 March, the anniversary of Percival Lowell's birth.

Minerva, Vulcan, Persephone and Pluto were all suggested as the name of the new planet, but Pluto, the god of the underworld, won. His name contained prominently the initials of Percival Lowell.

The prediction and discovery did not pass without some controversy. How could Lowell have been so close to the correct orbit when his value for the mass was so far out? A few years later the mathematician-astronomer E. W. Brown went so far as to conclude that the data available to Lowell were insufficient to determine the correct parameters. Obviously chance and coincidence played an important part in Pluto's discovery.

What has happened since the discovery of Pluto? The large eccentricity and high inclination of the planet's orbit, coupled with the fact that this orbit gets closer to the Sun than does the planet Neptune (as indeed is the case at present), led to the suggestion that Pluto was not a "real" planet, but was an old satellite of Neptune which escaped due to a close encounter with Triton, another satellite. Astronomers now know that Pluto is spinning every 6 days, 19 hours and 17 minutes with its equatorial plane inclined at about 50° to the orbital plane. The planet's surface is apparently covered with patches of methane frost interspersed with regions of lower reflectivity; its density is about 0·5 g/cu.cm, half that of water; its diameter is about 3600 km and its mass is $1 \cdot 1 \times 10^{22}$ kg, less than a sixth the mass of Earth's moon. Pluto, the planet, increasingly resembles Pluto the escaped satellite. **David Hughes**

Feedback

"And God said 'let there be light,' and there was light!" Discuss.

This is not practical cosmology. It is, if anything, theoretical cosmology, but in making this mistake R. G. Ware, of Morecambe, at least departed from the masses; most of the entrants for our Question of the Future competition were practical alright, but don't know what cosmology is.

Some general observations first. To most of you, The Rain in Spain is the essence of applied climatology. And quite a few have read, and admire *1066 and all that*; . . . perforate one side of the tape only . . . impart your answer to both sides of the disc . . . and so on.

As is fast becoming tradition, let us start with a selection of good single efforts, grouped in subjects:

Practical cosmology
Consider Olber's paradox in the light of . . .
a fine suggestion from
A. J. Speyer of Marcham

Draw a black hole (infant school exam)
Sica Chhuom, London

You are provided with a large energy source and a suitable vacuum. Prepare a system yielding intelligent life within 1·5 x 10^{10} years. Estimate the probability of a false positive. [Not practical, but no matter.]
Jim Rowan, Bromsgrove

Applied climatology
Consider what proportion of a given area's population must decide on a picnic on a given day to ensure precipitation, and discuss the possibilities for desert reclamation.
Martin Lewis, Kenilworth

What major types of climatic improvement are brought about by the application of fluorocarbons to the stratosphere?
S. C. Penny, Oxford

Advanced techniques in genetics
Owing to the monotony of canine conversation, the contemporary species is on the verge of extinction. State how the original "dumb" strain might be reconstituted.
J. M. Grant, Gerrards Cross

Enumerate the human genes which determine political allegiance, and calculate the lowest mutation frequency which would produce a Liberal majority in the House of Commons within 100 years.
Margaret Thorpe, Preston

Neuroengineering
A neuroengineer needs the following equipment: a) sharp knife b) wires c) hacksaw d) nervous patient e) all of these.
Susan Jenkins, Ware

"Two heads are better than one." Discuss, using examples from your own experience
Margaret Thorpe, again

Sketch the circuit diagram of a commercial prosthesis for converting gut reaction into considered opinions.
John Thorpe, Preston (family entry in one envelope—very frugal)

Compare and contrast the use of electronic and bacterial signal boosters in interpersonal neuron junctions. Transmit your answer only when required.
Jim Rowan, again

The prize winners we reprint in full. They will be getting their book tokens in due course. We would draw attention to the exceptional brilliance of Alan Jones's superb entry. Such cleverness deserves to be specially rewarded, so he gets a £10 token. No space this week for another competition, but we will have one next week. Thanks to all who entered.

Practical cosmology
"... to wind up the sun and moon,
Or curb a runaway star or two."
Byron, *Vision of Judgement*
Q. Compare and contrast the projects.

Applied climatology
"... the air; which, but for vacancy,
Had gone to gaze on Cleopatra too
And made a gap in nature."
Shakespeare, *Anthony and Cleopatra*
Q. Calculate what might have been a new position for the subtropical anticyclone.

Advanced techniques in genetics
"The Child is father of the Man"
Wordsworth, *My heart leaps up*
Q. Discuss, with examples.

Neuroengineering
"I am a Bear of Very Little Brain and long words Bother me"
A. A. Milne, *Winnie the Pooh*
Q. Describe the neuro-pathways which could be connected to alleviate this condition.
C. F. Carter, Northampton

Practical cosmology
The small container holds a mini black hole. Use it to convert the two left-handed gloves provided into a pair. Candidates unable to return the black hole after the experiment will be disqualified.

Applied climatology
"The rain in Spain stays mainly on the plain." Describe and explain the measures necessary to ensure this without affecting the climate of British Columbia.

Advanced techniques in genetics
Many married couples of different skin colour are known to speculate facetiously on the skin colour of their children. Describe the procedures necessary to;
a) produce black and yellow vertical stripes
b) produce *either* blue or green
c) justify your activities to the children concerned

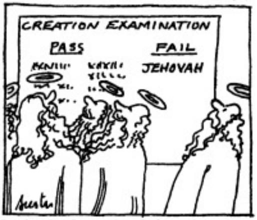
Neuroengineering
Design and construct from the materials provided an interface between your own CNS and that of the crab supplied. Describe how the aquarium and its surroundings appear to the crab.
IMPORTANT. The CNS link must be broken before beginning the answer. Papers which appear to have been written by the crab will not be marked.
J. M. Woodgate, Rayleigh

University of Creation
Institute of Advanced Theology
Final Year Examination
Paper I: Practical

Candidates must attempt all sections in the order given.

Section 1 Practical cosmology
In the container No 1 provided, you will find one void. From this you are to create a universe with an inhabitable planet. This planet should have earth, sky, water, night and day as an absolute minimum. Marks will be awarded for originality. NB Candidates are advised to create a handful of dust for use in section 3.
(Time allowed: 2 days)

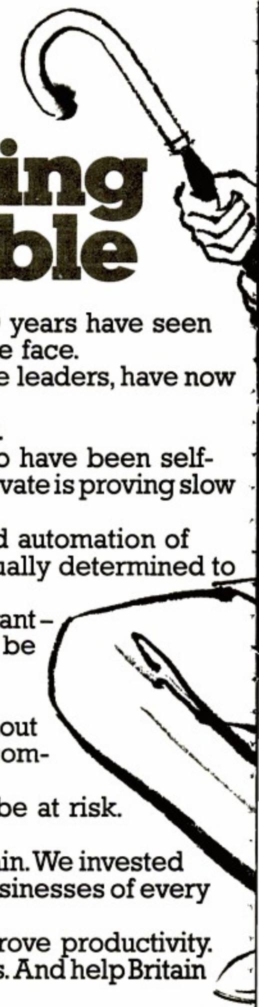
Section 2 Applied climatology
Devise a system of zoned climate and weather bands for the planet created in section 1. The weather created should be seasonable, with seasons varying with locality, and should be suitable for the propagation of the vegetation provided in container 2. (Time allowed: 2 days)



Section 3 Advanced techniques in genetics
Using any raw materials you wish, create a varied collection of wildlife for the planet. There is no limit on variety, but your collection must include aquatic, amphibious, air breathing, and flying creatures which must be able to reproduce their own kind. Other forms may be created provided they are able to thrive and multiply in the location in which you place them. Marks will be deducted for any imbalance introduced between sections 2 and 3. The handful of dust from section 1 is to be used to create a living being in your own image together with a breeding partner. These will be needed in section 4.
(Time allowed: 1 day)

Section 4 Neuroengineering
The life forms created at the end of section 3 are to be provided with the ability to think and reason, using a heuristic central nervous system. Candidates are warned to take extreme care in this section, as the slightest error could damage the delicate balance created in sections 2 and 3.
(Time allowed: 1 day)

Candidates will be allowed one day's grace before Paper II; THEORY.
Alan Jones, Dartford



Is British industry dying an honourable death?

The last 20 years have seen Britain rapidly lose face.

Scores of our industries that once were leaders, have now become followers.

Many, indeed, are in their death-throes.

To outside observers all this seems to have been self-inflicted. A country famous for its ability to innovate is proving slow to accept innovation.

Managers have disregarded the rapid automation of overseas competitors. Work-forces seem equally determined to resist progress.

Yet the very thing that British workers want – namely, a higher standard of living – can only be achieved by increasing productivity.

Automation is one solution to this. Admittedly it isn't the only solution, but without automation Britain cannot hope to remain competitive with the rest of the world.

Orders, jobs, and even factories will be at risk. Unless something is done.

At IBM, we believe in the future of Britain. We invested £136 million here last year alone, to bring to businesses of every size the automated systems they need.

Systems to expedite office work. Improve productivity. Cut manufacturing costs. Hasten delivery times. And help Britain compete with the world.

Out of Britain's 25 top profit-making companies 22 use IBM as their major supplier of automated business systems.

What can we do for you?

Whatever size your business, IBM can offer an automated system to help you. Word processors from £3600, computers from £11,000. Contact Andrew Biddlecombe, Portsmouth (0705) 694941

Forum

A GROUNDLING'S NOTEBOOK

Weighty issues

Donald Gould

I have often ranted and raged in these columns against the idiocies of our judges and justices of the peace, and as such protests may have made me seem to be a malcontent, only concerned to denigrate the authorities who God Almighty, in His infinite wisdom and mercy, has seen fit to impose upon us in this country, I am pleased now to report an idiocy from another place. A Mr R. Allen, who lives in Melbourne, Australia, has been kind enough to send me cuttings from a publication called *The Herald*, which is published in his home town. The cuttings are to do with a set of scales in a chemist's shop.

The chemist is a man called Mr Rush, and his scales are of that old-fashioned but excellent kind which don't flash up your weight in computer-type figures on a black strip, and which don't "speak your weight" in the fashion of the 1950s, and which don't disgorge a smudgingly printed ticket purporting to tell you not just your mass but also your fortune.

No—these are proper scales.

You have to stand upon the platform, and then you have to slide a weight along a notched arm of the machine until a pointer points to "nought". And then, using all the mensurational skills at your command, you have to deduce from the figures engraved upon those damned levers, and from various other factors, the answer you are after. It requires the undivided and dedicated attention of the user. It is not the kind of exercise you undertake simply for fun, or a cheap kick, or just to pass away an idle moment. It is a considerable exercise, and an innocent one to boot, since it neither bothers nor impinges upon anybody but the doer of it, and it has no discernible impact, either for better or for worse, upon the common weal. A reasonable person might conclude that treading upon those scales, and fiddling around with those sliding weights, was not the kind of ill-doing which ought to be proscribed by law.

Not so, according to the weights and measures inspectorate of Melbourne, Australia. Those functionaries, doubtless following many a grave discussion in committee, came to the conclusion that it was illegal for Mr Rush to keep those scales in his chemist's shop. He "inherited" the machine when he took over the business about 10 years ago. Since then his customers have used it free of charge. But last September, according to the law of the land, all public weighing machines were required to "go metric". Mr Rush's scales were, clearly, a public weighing machine, within the meaning of the Act. So they had to go.

And they are now rusting in his back yard.

This unhappy quietus of an accurate, much-used, and much-loved instrument, followed *four* visits by a weights and measures inspector, eager to do his bit.

Mr Rush is angry. He said that his scales were largely used by old people "who can't understand metrics", and also by pregnant women, who probably don't care much about kilograms either. On the fourth official visit the W&M inspector got so emotional about the issue that he tried to remove the scales himself. It must have been quite a tussle, because, according to *The Herald*, Mr Rush had to move them behind his counter in order to prevent their forceable arrest.

I do, of course, appreciate the point of view expressed by a Mr P. A. Brow, who is said to be the superintendent of weights and measures in the state of Australia in which Mr Rush has his place and being (and, until quite recently, his scales). Mr Brow is reported, by *The Herald*, to have said that "Mr Rush's actions negate the purpose of metric conversion, which was to get rid of imperial transactions."

Exactly so. And I am glad to find Mr P. A. Brow taking this attitude. After all, the more time and energy which people like Mr P. A. Brow spend upon issues of this kind, the less time and energy they will have to spare for crudding up issues which actually matter. □

JOKING ASIDE

Antigravity at last

John Gribbin

I seem to have bitten off more than I intended with my various pleas to "keep those letters and postcards rolling in". Taking me rather literally, our esteemed Letters Editor has dumped some of his burden in my lap, under the impression that the lunatic fringe clearly falls within my domain, even though I have tried to achieve respectability by changing my columnar description. I *would* have told him what to do with his bundle of goodies, except that they provide me with a belated opportunity, only one month late, to bring you antigravity—as promised (nay, *forecast*) on 17 January in these very pages. (I am also still smarting from the Editor's criticism of last month's column as "naive hippiedom". Let's see how he likes this.)

Antigravity's ugly head was actually reared on Valentine's Day, 14 February, by our patents reviewer, who says that the US military is now taking seriously the patents filed almost 10 years ago by Henry Wallace, covering ground similar to the independent discoveries involving the bizarre properties of spinning gyroscopes made by Eric Laithwaite. But the idea, in this form, goes back much further than that, and as regular readers (or maybe it's just the one regular reader left now?) know, in times of stress (naive? *hippy??*) I turn for comfort and authority to my favourite reference work, *Analog* magazine. Back in the good old days of the early 1960s, *Analog*, under the crusading editorship of John Campbell, thumped the tub loudly for a gyroscope-based "space drive" developed by one Dean and dubbed the Dean Drive. This device, seemingly, produced masses of erratic thrust (measured on the bathroom scales) but never actually got off the ground. The last I heard, in the middle-1960s, many patents were filed and everything was being covered up by, of course, the US military. In 15 years since then the US military has come up with many impressive, unlikely and unwelcome developments—but no antigravity. What went wrong?

Well, turning for solace, etc, to the pages of my favourite magazine, what do I find in the April 1978 issue (vol 98, no 4, p 43) but an article about the Dean Drive and all its relations, by one Russell E. Adams. Like many others, Adams got turned on to the Dean Drive by John Campbell, and actually tried to build a replica before going off to college and forgetting the whole thing. Years later, armed with a little education, he tried again, starting out from the 50-odd patents on the theme in the US Patent Office—Dean, it seems, was far from being unique and certainly not the first down this trail. Adams then made a thorough study of what he calls "the bootstrap effect", and produced, in *Analog*, what should be essential reading for all antigravity freaks, complete with working (rather, non-working) models and comprehensive bibliography. In a nutshell, and sorry to disappoint you, they *don't* work; none of the models produced any measurable thrust, and this, perhaps, is the reason why those tests by the US military are so secret—they, too, do not indicate any space drive potential. If they did,

"GOING BACK TO THE DRAWING BOARD?"
PETTJW

would the US still be persevering with the expensive and embarrassingly ineffective space shuttle?

But what, you ask, about those letters? Where do they come in? Has one of these correspondents really invented a space drive? Not quite, although they've done their best. Following Paul Davies's article on antimatter (31 January, p 305) several queries about the gravitational properties of mirror image particles have come in, along the lines that antimatter should have antigravity, or negative mass, and therefore would be repelled by ordinary matter which is why there isn't any antimatter in our (material) part of the Universe. Nice try, but it doesn't work that way in the real Universe. When antimatter particles (such as antiprotons) are accelerated in, well, particle accelerators, they go where they are pushed—pushed to the left by magnetic fields they go to the left, not to the right. So their inertial mass is the same as that of ordinary matter (though *why* this should be so is another story), and a matter planet and an antimatter planet would attract one another gravitationally. A moment's thought gives us another indication that antimatter has positive mass. When proton and antiproton meet, they annihilate as a burst of energy, each contributing mc^2 to the total. If one had negative mass, the annihilation would produce *zero* energy (mc^2-mc^2) and the particles would just softly and silently vanish away. Once again, practical tests pull the rug from under the armchair theorists.

Isn't it boring when experiments disprove our fancied theories? And isn't it irritating of the Universe to be so illogical as to give antimatter positive mass, while reversing its electric charge and other properties? It just shows how far up a blind alley you can go through making naive assumptions. I'm so disillusioned by the whole business that I think I'll turn my attention to biology. You have been warned. ☐

MEDIA MESSAGES

In whose opinion . . .

Tim Robinson

Public opinion is notoriously fickle. It is useful to those who feel they have it in their pocket; but the assumption is that it is both open to persuasion and yet always free, just beyond the grasp of reason. There was a time when it could more easily be captured, netted by journals of *opinion*, calculated to hold the attention of the great and the good long enough for them to read, pause, then continue on their way, armed with the means to let lesser men know just what was what.

Democracy, among other things, has changed all that, for today we may all have and hold opinion, and may well be asked for it in the streets by toothsome interviewers from the telly, or subtler slighter folk with clipboards and pens.

Yet this strange, often unlovely creature is still a potent symbol of power, the more so for being difficult to pin down. The righteous noise assailing our ears and eyes from today's nannyish press (supporting, as ever, the past misread as the future) currently claims public opinion for its own. It lies, but who's to "front it with the truth?" The trick is never to let the facts spoil a good story, as someone once wrote of hackdom. And in good old deferential Britain the simplest way of ensuring that is not to *invent* facts—though that's been done often enough—but to *assert* the case one is trying to prove.

Let me give you a couple of examples, one historical, one from a couple of weeks ago; both have much to say about the role of our mass media in obfuscating plain facts. I mentioned the nanny press; let us turn to "aunty" for a moment, the BBC. Thirty-five years ago this august body decided that the power of broadcasting really was a threat to democracy and for more than a decade voluntarily banned from its programmes any discussion of issues likely to be debated in parliament in the ensuing fortnight.

The breathtaking scope of this self-denying ordinance became apparent almost immediately: in theory it could have put all the BBC's current affairs and news programmes out of action indefinitely. Only the torpor of MPs, whose imagination for useful debate was then, as now, extremely limited, saved the day. Senior politicians, however, having watched the BBC carefully stumble into its own gintrap, refused to allow it to retract: the Fourteen Day Rule passed into legend *and* harsh reality.

The assertion from Westminster was that prior discussion of topics of national importance by the BBC would both undermine something called the sovereignty of parliament *and* could lead to public opinion swaying the judgement of our intrepid MPs. In defence of these positions people of the calibre of Herbert Morrison had to invent a metaphysics of such obscurity the Scholastics would have despaired. Perhaps the pinnacle of this particular seating of angels on a pinhead was the assertion that public opinion would not allow a reduction in parliamentary sovereignty, that same opinion which could so easily undermine it given half the chance. The footnote to this unhappy saga is of course that until the BBC thought of it, politicians had previously not noticed anything wrong.

Well, the Fourteen Day Rule has passed away—though it has never formally been abrogated by any government since the BBC announced in the late 1950s it would no longer adhere to it—but our MPs go on insisting their "rights" are often threatened by broadcasting and sometimes the press as well. The most recent case which comes to mind is that of the Corrie Bill, attempting to restrict abortion rights severely. It has, this time round, failed: killed in fact by concerted efforts by liberal MPs of all parties, backed by a considerable public opinion, for once reinforced by opinion polling.

That did not stop Corrie, who cleverly forgot it was supposedly public opinion of a different kind which stirred up the whole affair to begin with, remarking when the Bill began to falter that the true lesson to learn was that organised public opinion was in serious danger of undermining . . . To my best knowledge the mainstream media have passed over the anti-abortion lobby's engineering of opinion.

I suppose we all want easy answers, comfortable ones. Public opinion, or in the memorable phrase of the unlamented Spiro Agnew, "the silent majority", can be turned into an easy but powerful "answer": it is what "they" want. All media err in finding either the glib populism of the polls, or the assertions of some expert or other about people's attitudes, sufficient in determining the path a democracy's representatives should take. Those representatives have too long used the media's interpretation of this version of public opinion as a shorthand for the truth.

A very extensive poll in the *Sunday Times* last week demonstrated (within its own limitations) that we are very complex and contradictory animals, loving and hating (often the same things described differently), acting selfishly while making great sacrifices.

If the media believe they hold the ring between light and dark, democracy and totalitarianism, they have to recognise first the awkward fact of this complexity; and use it to chip away the shell surrounding the ungraspable truth. Both public and media could learn a lot. ☐

THIS IS THE WAY TO GO
PETTJW

WASHINGTON VIEW

Submarine SUMS

Dan Greenberg

With the US planning to build the post-Minuteman MX missile system, and Britain shopping for a replacement for its ageing Polaris fleet, it's in the realm of the scandalous that neither country has paid serious attention to an intriguing proposal for what's plainly a reliable, secure and inexpensive new missile system for the latter part of this decade.

Known as the shallow underwater missile system (SUMS), the proposed scheme has been championed here by two of the most respected figures in the Pentagon's ranks of high-level scientific and strategic advisers—Richard Garwin, of IBM, and Sidney Drell, of Stanford University.

SUMS, quite simply, would consist of a fleet of tiny submarines, each carrying two long-range missiles strapped to its hull. These vessels would operate close to shore, so that they would be within range of friendly forces and simple communications. They would not require deep-diving capabilities, high-speed propulsion systems, or any of the other costly characteristics of the big, seagoing underwater missile carriers. Rather, operating within a couple of hundred miles of home coastlines, they could cruise at very modest speeds and depths and still have more concealment than the multi-billion MX landbased system can ever achieve with its scheme for moving missiles from shelter to shelter within an area of a few square miles.

Garwin and Drell—both top level physicists and long time consultants to the Department of Defense and the White House—argue that the submarine technology exists for creating the system. The West German navy already has in service for non-missile purposes the very type of submarine that could be adapted for the SUMS proposal. These are diesel-electric craft of 400-500 tonnes, with crews of approximately 15.

They have to snorkel periodically, but being within range of anti-anti-submarine forces, that's no great hazard. As envisaged by Garwin and Drell, the evolvement of fuel-cell technology would provide for greater concealment and efficiency. But that's not a crucial point with the system they're proposing.

The arguments that can be raised on behalf of SUMS are numerous, but chief among them are cost and reliability of communications—an extremely difficult and uncertain matter with far-ranging submarines. As for cost, it's hard to compare the price of 200 seagoing missiles on 100 inexpensive submarines with the MX system that the US Air Force wants to build in the western US. The landbased MX cost estimates range from $30-60 billion, but no one here has any faith in these figures. Garwin and Drell are cautious about the costs of their proposal, but they say that when it's all put together from doing all that's needed to acquire the system and operate it, the cost should be substantially less.

As for communications, our navy's long—and still raging—struggle to acquire a huge piece of real estate for construction of an underground, very low frequency submarine communications system is evidence of the difficulties of getting through reliably to faraway submerged craft. The SUMS system, on the other hand, would be so close to shore that it could actually be connected by very fine, reeled-out wire to submerged communications posts. Or, again because of the proximity of friendly forces, these small craft wouldn't have to be fearful of surfacing an aerial. Operating so close to home that the approach of hostile anti-submarine forces could be detected far off, the SUMS force would enjoy a kind of sanctuary not available to long-range submarines; and their area of concealment would, of course, be enormously larger than that available to landbased missiles—even mobile ones.

Given the merits of the proposed system, why hasn't it at least got enough attention to be argued about in the course of our long debate on the MX system? The answer offered by Garwin and Drell—who have both advocated the system in congressional hearings—is that our military provides no institutional constituency for these small underwater boats. The MX is in the custody of the air force, which has no interest whatsoever in turning it over to the navy. Meanwhile, the navy, which is building a fleet of 18 000-tonne trident submarines, doesn't like to be told that these billion-dollar Behemoths can be adequately substituted for by a handful of 500-tonne miniatures.

The net effect of these service interests has been a virtual absence of serious discussion of a sensible solution to the next step in the lunacy of the strategic arms race. Garwin and Drell are confident that as the Trident costs mount and environmental opposition makes it difficult for the air force to get its landbased MX sites, interest will inevitably turn towards the SUMS. Maybe. Meanwhile, as Britain weighs various post-Polaris technologies, it might be useful to consider the Garwin-Drell proposal. □

EXPERIENCE

Blood money

Ed Harriman

As anyone who has been there knows, Belize is a slum. Even the main streets of the Caribbean Crown Colony are awash with sewage and flotsam between unbelievably ramshackle façades. There is almost no work, aside from cutting cane for Tate and Lyle. So perhaps it comes as little surprise that it is also the home of one of the world's more dubious businesses—the traffic in human blood. The man who runs the business, a Cuban American doctor named Pedro Ramos, had to flee Nicaragua two years ago after the editor of the only opposition newspaper in the country was assassinated for printing articles showing Ramos was then exporting Nicaraguan blood in partnership with the now-deposed dictator, Anastasio Samosa.

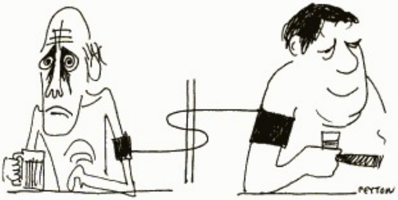
It is not difficult to find Ramos's Belize operation. Behind the Barclays Bank building in Belize City, down a potholed road, donors—mostly emaciated alcoholics—in the Roque R. Ramirez bar, slouch in stupefied hazes waiting to stumble across the road twice a week to the Plasmaphaeresis Centre. There, after their haemoglobin and protein counts are checked to make sure they are neither anaemic nor undernourished, they lie on cots while a litre of blood is drained off. The red cells are spun down in a centrifuge and transfused back. The rest—about 600 cu.cm of plasma—is frozen and shipped to Ramos's headquarters, Daco Distributors in Miami.

For this the men are paid £2 for the first, and £2·50 for the second letting each week, and are given a chit entitling them to a hamburger or bowl of soup at the nearby Happy Hour Cafe. The money often goes on drink and marihuana. Some of the "registered" donors give blood as often as 50 times a year. And they are reviled by many Belizians. As one of the numerous beggars, shoeless with torn trousers, shuffling past Barclays Bank put it, "I give to people who need it, sir. To give people life. Not for them to make money."

Nonetheless, Ramos's business is advertised on local radio. Doctors in the Belize City hospital tell how, time and again, they have lost patients—many of them young men brought in with stabbing wounds—simply because there has been nothing in the blood bank. Yet they are afraid to speak out.

Ramos's partner this time, owner of the adjoining health food shop which sells honeyed protein pills and sexual invigorators at extortionate prices, is none other than Mrs Maude Sylvestre, wife of the Minister of Energy and Electricity. They are both doing well. The plasma is sold by Daco for between £20 and £24 a litre to pharmaceutical houses, to be fractionated into albumin, gamma globulin, anti-haemophilic factor "8" and other constituents to be sold worldwide.

Ramos does not want to talk about Nicaragua. The murder of Pedro Chamorro, the newspaper editor whose widow now sits on Nicaragua's revolutionary junta, set off a two-week



general strike. Ramos and Samosa's factory was burned by Chamorro's mourners. And Ramos fled.

He is more forthcoming about the League of Red Cross Societies and the World Health Organisation, both of which he castigates as being wittingly hypocritical; both have been campaigning against commercial plasmaphaeresis throughout the Third World. "The Red Cross buys plasma from paid donors," Ramos insists, speaking from his Miami office. "But not directly. They used to buy it from me through Travenol (a drug house) in Brussels, and it would end up at the International Red Cross in Geneva. That came from Nicaragua and Belize."

Not surprisingly, Dr Z. F. Hantchef, head of the Red Cross's Blood Transfusion Service in Geneva, hotly denies Ramos's claim. For years he has been speaking out against unscrupulous dealers. But Ramos is undeterred. A self-acknowledged world expert ("In all modesty I operated the largest centre in the world for many years in Nicaragua"), he derives cool satisfaction from the dour fact that since the US Fderal Drug Administration introduced regulations governing American commercial plasmaphaeresis in 1973, more than 350 centres have sprung up there.

Yet he is still intent on keeping his Belize source alive. It is by far his cheapest, and his last in the Third World. (It seems Ramos was expelled from Costa Rica, Honduras and Haiti, as well as Nicaragua, before finding safe haven in Belize.) Ramos also claims the Crown Colony blood is FDA approved. That may be. But there are no on-the-spot tests of donors for alcohol, hepatitis or drug abuse, all of which are common in the Roque R. Ramirez bar. "It's kind of political," Ramos sums up. "You keep it quiet, you know. They say it's poor people who donate plasma, and that the people who take it are vampires. So you see, it's best kept in low profile." No doubt that is true. ☐

WESTMINSTER SCENE

EEC and water pollution

Tam Dalyell MP

Late at night, when the main business of the Commons for the day is completed, a whole series of EEC directives comes up for debate. Some of them are very important, others less so—but either way they are too late to be reported in the following day's newspapers, and too complicated to get a mention in the BBC Radio account of the House of Commons debates the following morning. Such was the fate of the proposals on drins (a group of toxic chemicals) and mercury. They were the first offspring of the EEC directive of 4 May, 1976, dealing with "pollution caused by certain dangerous substances discharged into the aquatic environment of the Community". Dangerous substances are grouped into a black list and a grey list on the basis of their polluting effects.

Marcus Fox, Under Secretary of State for the Environment, told the House that the drins should indeed be controlled, but that they are not in wide use. We are affected mostly by discharges of dieldrin from our mothproofing industry, largely based in Yorkshire. Fox said that there was room for doubt as to whether such a limited proposal justifies a Community directive. He added, "In the early negotiations in Brussels, we raised this question, but the Commission has been under pressure from a number of countries to make progress with proposals under the parent directive, and the drins obviously seemed a simple place to start". I interrupted Fox at this point to ask what the reply was from the Community when he raised this question in Brussels? Some of us with experience of the Community think that this sort of blanket approach in directives is sometimes daft. In the opinion of many MPs, the next Commission and Roy Jenkins's successor should be exceedingly careful not to bring the Community into disrepute by putting forward directives that are less than necessary.

However, as Fox pointed out, mercury is less simple in prospect, because it is widely used, and also occurs naturally. The EEC Commission has chosen to concentrate upon the chloralkali electrolysis industry, which it thinks is a "principal source" of pollution caused by mercury discharges into water. The CBI rejects this view, saying that mercury discharges from this industry have not caused harmful pollution within the terms of the definition specified in the parent directive. The British government has some sympathy for the industry's point of view. Companies such as ICI have spent considerable sums of money in recent years to reduce the amounts of mercury discharged to the waters concerned, which have in any case been carefully monitored by the relevant water authorities. "The fact is, however", added Fox, "that in Community terms the chlor-alkali industry is the largest single discharger of mercury, and was therefore the likeliest target for the legislators to pick off first."

The truth is that controlling discharges of dangerous substances on the industry-by-industry basis proposed by the EEC Commission is not the UK's approach. Our concern is with the quality of the water which may be affected by a number of different discharges, and in the case of mercury, by some natural levels. Britain believes in distinction by use. It really is absurd to cater for the Mediterranean and the North Sea in the same directive, since conditions are totally different. Mercury in the Med really is a problem. Equally, should one lump together fast flowing rivers, such as the Spey, and slow moving rivers such as the Po, or for that matter the Rhine, the major source of EEC worry? Above all, there should be an approximate price-tag fixed to the costs of every directive. I am as concerned as anyone about the environment. However, let us recognise that the environment's cause is not well served by regulations which are enormously expensive, and almost certainly less than necessary.

* * *

One thing I have learned over the past couple of years is that when their views are criticised, many, though not all, anti-nuclear campaigners react with about as much grace as the West Indian cricket team facing the prospect of defeat in New Zealand. In particular, those against the Torness nuclear plant have tended to take refuge in ill-temper and sarcasm, when I have suggested that in their questionnaires, they might ask some questions that are not slanted to their point of view. For example, I proposed that on the next occasion they saw fit to put their questionnaires round the people of the East Lothian constituency, they might add questions such as, "Are you prepared for your children and grandchildren to go short of electricity?" or "Have your yourself ever been down a coalmine?" They did not take at all kindly to the suggestion!

I just think it is high time that when there are only three major future possibilities for adequate supplies of electricity on the horizon—coal, energy-saving, and nuclear—that people should be made to face up to the consequences of their sloganising anti-nuclear questions. As it is, far too many of the anti-nuclear campaigners want to have their muddle-headed bread and eat it. It is also high time the pro-nuclear forces got a bit tough. For my part, I am trying before I next go to Ayrshire and the area of Loch Doon to get hold of one of those perhaps tasteless, but effective American stickers which reads, "More people died in Senator Kennedy's car at Chappaquidick than at Three Mile Island!" ☐

Letters

Quality assurance

In his Comment, Dr Wolfgang Passl (21 February, p 546) applauds the concepts of the US Food and Drug Administration's "Good Laboratory Practice" regulations and advocates quality assurance applied to research work generally. He omits two points. First, *good* quality assurance is always self monitoring in terms of its own effectiveness and of cost-risk-benefit; the rigid GLP regulations preclude this. Secondly, it is of little value to achieve impeccable quality of experimental work in a regulatory field of activity unless all other parts of the chain leading to an official action are of comparable quality.

Legislation is a political act, its quality is only definable in political terms, ie does this decision help maintain possession of authority by a government or a civil service agency or department? One has only to examine the differences between national laws on, say, food additives, to appreciate that political considerations dominate decisions and that science, good, bad or indifferent is accepted or ignored as is politically expedient.

The US Food and Drug Administration itself provided an obvious example when it fished in the results of a seriously spoiled experiment to produce the desired condemnation of the substance under test.

Whether the ritualistic animal feeding studies concerned merit the term research is another matter.

True innovative exploratory research involves intuitive and extrapolative thinking as well as experiment. It will blunder, jump to wrong conclusions from good work and achieve new insight from grossly inadequate experiments. Its quality is only determined by its contribution to the advancement of science.

W. H. Nightingale *Wirral*

Interferon

In reply to Ian Miles's letter about the possibility of viruses developing resistence to interferon (21 February, p 597), I would make the following points.

First, interferons do not act directly on viruses (unlike penicillin inhibiting bacterial growth) but boost normal cellular enzymes that have evolved to control virus growth.

Secondly, as I indicated in my article (24 January, p 230), interferons induce several different defence mechanisms in the cell so that for a virus to be truly resistant more than one mutation would probably have to occur in most viruses.

Thirdly, interferons are produced by all vertebrate species studied (and possibly by some invertebrates as well) and have thus been conserved during evolution and active against viruses for many millions of years.

Thus if mutant viruses resistant to interferons occurred with the frequency of bacteria resistant to antibiotics, it would be expected that by now most viruses would be completely insensitive to interferon. However, the majority of viruses are very sensitive and although different virus types vary in their sensitivity to interferon, within any one type of virus mutants resistant to interferons cannot be found.

Although the possibility of viruses becoming resistant to interferon cannot be completely ruled out, and if they did it would obviously be a serious problem, evidence so far indicates that this is unlikely to occur.

F. Balkwill
Imperial Cancer Research Fund *London*

I would have thought that the beauty of the interferon as a means of preventing disease is that all it involves is augmenting the natural response of the body. Antibiotics are a different kettle of fish altogether as they are produced outside the human body from species such as moulds. Their introduction into the body is unnatural and it changes the internal environment of our body, creating spaces for new resistant bacteria.

Michael Mansfield *Sidcup*

Uranium markets

"Uranium mountain weighs on nuclear decision" (This Week, 21 February, p 549) is a good summary of much of our argument, but there are three points at which our final draft differs substantially from your report.

First, while we believe that there will be strong downward pressures on uranium prices over the next decade, neither we nor anyone else can be certain that, as you report, these pressures will be maintained as far as the year 2000.

Secondly, we do not argue that *all* cost pressure will be in a downward direction; in particular, there is the possibility that stricter safety and environmental standards may act in the opposite direction; nevertheless, we still argue that, because of higher ore grades and technical advance, the net effect will be lower average costs.

Thirdly, contrary to the first sentence in your final paragraph, we maintain that uranium-saving research does deserve high priority, but that the existing distribution of research resources is too heavily skewed towards one uranium conserving strategy—the liquid metal fast reactor.

G. S. Mackerron
A. J. Surrey
University of Sussex
Science Policy Research Unit
Falmer

Risks

H. J. Dunster's statement that "a genetic mutation is certainly not a permanent feature of mankind unless it is beneficial" (Letters, 21 February, p 598) is a little difficult to relate to either contemporary genetics or to the vernacular.

Permanent disability after an accident is terminated by death. Mutational disability is, by nature, not bounded by death, and may not manifest itself for centuries. The minority of recessive mutations which became established by chance will stalk man for millenia.

Would Dr Dunster explain the relative hazard, in the

Grimbledon Down **Bill Tidy**

BLASTED TOFFEE... CHEWING GUM! I'M SICK OF THE ANNUAL 'YOUNG SCIENTISTS OF THE YEAR' VISIT!
IT ENCOURAGES THE KIDS TO LOOK AROUND A BIG SCIENTIFIC ESTABLISHMENT...
..AND GOD KNOWS WE NEED NEW BLOOD IF WE'RE TO - OH DAM' THE CONFOUNDED STUFF!
HA... DIFFERENT STORY NOW, EH!
OUR NU FOOD CHEW JUST WILL NOT STICK!
SPLAT!

view of the Health and Safety Executive, of substances which are mutagenic but not carcinogenic and those which are both mutagenic and carcinogenic?
J. H. Edwards *Oxford*

Professor Edwards asks for the view of the Health and Safety Executive on mutagens and carcinogens. Both, like other toxic agents, are undesirable but inevitable components of our working and domestic lives. The Executive's view is clear, although it needs considerable judgement in application. Avoid all unnecessary exposure—keep all necessary exposures as low as you reasonably can—in any event keep exposures below any limits which have been set by consultation procedures or are recommended by professional bodies, such as the British Occupational Hygiene Society, or by the Executive.

The permanency of mutations was a minor point in the original letter on which I was commenting and I reply to Professor Edwards with trepidation. I took my stand on the process of natural selection. Disadvantageous mutations are eventually bred out but not without human detriment during that process. I defy anyone to make any precise comparison between one death and a number of disabilities distributed in time. Although attempts have been made, and they can be useful in judging the allocation of resources, they are necessarily crude.
H. J. Dunster
Health and Safety Executive
London

Only for the boys?

It was a salutary coincidence that B. A. Proctor's letter (p 677) on the male ethos of science should appear in the same issue as the three page extract from Peter Medawar's *Advice to a Young Scientist* (28 February, p 664). It seems that the latter (both extract and book) reveal more than the author intended and certainly go some way to answering Mr/Ms Proctor's query. Throughout, the scientific community—from swimming pool attendant to FRS—is referred to as principally male—the implication being that this great scientist at least thinks science is "for the boys". I'm sure that Sir Peter, if challenged, would deny this, in which case it is all the more important, surely, that we should avoid in our language the implicit assumptions that we should wish to deny to our schools and the community at large.
Richard Clarke
Kingston-upon-Thames

Unless B. A. Proctor is a woman, should he not ask himself whether the fact that Daddy shows his daughter *New Scientist* and writes letters to it has anything to do with her view that science is "only for boys"?
Joan F. C. Reeves *Wilstead*

Where the blame lies

You include in Sir Peter Medawar's article "Advice to a young scientist" (28 February, p 664) a collage of drawings indicating a young scientist considering the various alternatives for a scientific future. All six drawings portray men as scientists. It is images like these which are responsible for perpetuating the myth that science is essentially a male preserve. Perhaps in future you will remember that women too are scientists.
Jeanette A. Samundsen
Reading

Snap shot

With reference to the Landsdown's advertisement (28 February, p 699) for a microbiologist (food industry) to "work" in Abu Dhabi—why female and why photograph (recent)?
Bob Carr *Salisbury*

Frozen fire

W. B. Fu (Letters, 31 January, p 344) comments on my recent article on the hazards of liquefied natural gas ("Gambling on 'frozen fire' ", 10 January, p 70).

It seems Fu and I agree that propylene is more detonable than LNG. Indeed, some experts feel LNG clouds will not detonate. We evidently disagree as to the importance of the two liquefied gases' similarities. Both are transported and stored as liquids, and both when spilled form flammable vapour clouds; the 200 dead from the propylene fire at Los Alfraques clearly testify to that, along with the 130 dead from the LNG fire in Cleveland. Los Alfraques demonstrated that even a small spill can cause enormous damage. The LNG ships into Canvey carry over 600 times more liquefied gas than the Spanish road tanker, and should one have a serious accident, Los Alfraques would pale into insignificance.

Fu contends further that "very simple calculations can be performed" to disprove my statement that estimates of the distance downwind an LNG plume from a 25 000 cu.m spill on water would remain flammable range from a few to 80 kilometres. I can only refer him to the US Coast Guard, *Predictability of LNG Vapour Dispersion from Catastrophic Spills onto Water* (April, 1977), which lists eight estimates of the maximum distance the plume would travel to a "time average" vapour concentration of 5 per cent: US Federal Power Commission (1·2 km), Science Applications Inc (1·9), American Petroleum Institute (8·4), Cabot Corporation (18·5), US Coast Guard (26·2), US Bureau of Mines high estimate (81·0). Fu's own estimate is 14 km.
Lee Niedringhaus Davis
Aarhus

Silicon doom

"Cheerio cheap chips" (This Week, 21 February, p 550) brings to notice a problem which has serious implications for the future of our civilisation.

A significant factor which might limit the availability of "cheap chips" is reported to be a drying up of the source of silicon from which the chips are manufactured. I believe that more concern should be shown over the indiscriminate exploitation of silicon by the electronics industry and more effort made to recycle silicon waste.

—AND WHO HAS THE WORLD'S BIGGEST HEAP OF SAND?
SILICON SHORTAGE

Indeed, unless the Earth's resources are managed in a more efficient manner, we could find ourselves with a "silicon crisis" as the world's supply is exhausted, which will be as far reaching as today's oil crisis.

Now is the time for concerted action: we must stop regarding silicon as if the supply is limitless and

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No. 55 —ENIGMA—

Nearly right

Eric Emmet

Uncle Bungle does not seem to be giving away much information in his latest football puzzle, in which four teams—*A*, *B*, *C* and *D*—were eventually going to play each other once. I am sorry about this and I fear that you will find the situation even worse when I tell you that *one* of the figures given was wrong. "Well, anyway," he said rather proudly, "it is nearly right." The document that he handed over to me looked like this:

	Played	*Won*	*Lost*	*Drawn*	*Goals for*	*Goals against*	*Points*
A	2				4	0	2
B							3
C	2		1		3	3	
D	3				8	5	2

(Two points are given for a win, and one point to each side in a drawn match.) Which figure was incorrect? What should it be? Find the score in each match.

A £5 book token will be awarded to the sender of the first correct solution opened on Wednesday, **26 March.** *Please send entries to Enigma No 55,* New Scientist, *King's Reach Tower, Stamford Street, London SE1 9LS. The Editor's decision is final. The winner of Enigma No 53, Calculating Birthdays, was Mr A. P. Brooke of Wallington.*

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Letters

continued

recognise that at the present rate of consumption the time is not too distant when the shortage of silicon will cause even more unemployment and economic problems than are anticipated during the present silicon boom.

J. F. Bowler Chipping Sodbury

Skiing and skating

I cannot accept that the frictional heat generated by a skate moving over ice would be sufficient to raise the temperature to its melting point to produce a film of water as suggested by Professor J. F. Nye (Letters, 28 February, p 676); the all-important film is surely produced by quite a different principle.

Water expands on cooling from about 4°C and continues to expand after changing into the solid (ice) state. Ice in equilibrium with its surroundings when pressurised will respond to the perturbation in classical Le Chatelier manner by a reduction in volume, which may be effected isothermally by some melting. The pressure exerted by the weight of a skater on the knife-edge of his skate is, of course, enormous and enough to make the water film. The phenomenon can be simply demonstrated by hanging a length of piano wire, weighted at each end, over a slab of ice in a cold room. The wire will slowly, and isothermally, pass right through the slab without actually dividing it in two.

James A. Fowler Leicester

Low tar smoking

Lois Wingerson's article (This Week, 28 February, p 635) has missed a key point in the report of Dr Tim Higenbottam *et al's* research (*The Lancet*, 23 February, p 409) into the behaviour of smokers changing to low tar cigarettes.

These researchers have, unfortunately, used the term "low tar" cigarettes when in fact he was referring to filter cigarettes with a tar yield of 18-23 mg—the middle tar category in government tar tables. This is made clear in Figure 4 of their report.

Silk Cut, defined as a low tar cigarette (10 mg or less in government tar tables), achieves its additional tar reduction by ventilation as well as by filtration and therefore has a reduced yield of the gas phase as well as the tar.

WE REFER, OF COURSE, TO THE SHORT SAILOR.
LOW TAR
NAVY CUT
CIGARETTES

It is true, as stated by the report, that some smokers on changing to cigarettes with lower tar levels compensate partially but not fully for this reduction in tar.

However, if they change to a low tar ventilated cigarette they will also obtain a reduction in the gas phase. Even after any compensation, smokers switching to low tar ventilated cigarettes would on average be exposed to lower levels of both tar and gas phase.

Dr Higenbottam's conclusions do not therefore appear to contradict those of the Hunter committee.

M. E. H. Mulholland London

Man and electrostatics

I wrote "Dowsing, ley lines and the electromagnetic link" (20/27 December, p 948) in the hope that it would provide a simple and scientific explanation of dowsing. My aim was to show that man is sensitive to anomalies in *electrostatic* fields and that the "output" is best considered as a dowsing reaction. (*New Scientist* incorrectly chose "electromagnetics" rather than "electrostatics" in the original title of my article.)

It would be easy to repeat the experiments using the dowser's response to an unknown voltage in a wire as a proper double blind test. So far as I am aware, no one has ever tested the dowsing reaction in this way. I believe it is entirely logical that our sensory nerves should be able to feed information on changes in the electrical environment into the brain. With the brain sensitive to minute electrical signals, it is hardly surprising that the electrostatic fields associated with natural or artificial (DC) electric currents should produce various sensations.

Prehistoric man was probably much more aware of these effects than we are. He would have been able easily to perceive the lines of electric stress in the lower atmosphere and use them for navigation by marking the points of high field strength with standing stones etc.

Because people differ in sensitivity, those most affected by the field would attribute the effects to "holy places" and would then imbue the whole ley signal network with religious significance. We continue to do it today—at places like Knock and Lourdes.

My experiments should be repeated on a larger scale, and a ley signal map covering the whole of Great Britain should be drawn up. From the work I have done already, I suspect that such a map would pinpoint many ley signal anomalies typical of outcrops of conducting minerals (coal, iron, lead, uranium etc). This might one day turn into a commercial technique. Unfortunately, the best method of detecting is still dowsing on foot, and thus a large voluntary effort (students?) would be needed. It should be possible to detect ley signals by logging anomalies in the radio field strength. The 30-100 MHz wave band contains wavelengths short enough to react with the typical ley signal profile.

Anthony Hopwood
Upton-on-Severn

Hannay diamonds

There seems no reason to doubt that fragments of diamond were submitted by J. B. Hanney in 1880 (Heritage, 21 February, p 591), but the question remains, were they actually made by him? Professor H. E. Roscoe announced at the time that a diamond crystal had been produced and identified as such, but took care not to endorse the claim that it was an artificial product. On the other hand we have the famous letter to *The Times* which has been quoted so often.

Successful or not, Hannay gave up scientific research not long afterwards because nobody would back him. Why this was so was not disclosed, but his career was cut short.

Unfortunately, there are other experiments of his which were published although his results were peculiar, besides a paper on the metallurgy of lead which was rejected by the Royal Society. It seems that Hannay's results could not always be trusted, to put it mildly. If circumstantial evidence be admitted then the case against is strong, far stronger than if only the diamond work is considered. Professor Roscoe's doubts were not fully expressed in public but there is no doubt that he or somebody else prevented Hannay from adding to a short but remarkable list of publications. The conclusions are obvious.
J. Jocelyn *East Kilbride*

Hope of the 'feelies'

What is the best way of demonstrating modern scientific achievements, both practical and conceptual, to the general public? Television is powerful but ephemeral. Printed words and pictures are more tangible but are they always exciting? Museums are not powerful influences, nor do they have an exciting image but this view is changing as was revealed clearly by Roger Hamilton in "Changing faces of natural history" (31 January, p 336).

Although the success of the British Museum (Natural History) gallery *Introducing Ecology* is the subject of some debate, the philosophy underlying the display is to be applauded. The swing away from science which was observed in Britain some 10 years ago must not be allowed to happen again and museums have a vital role in telling the public, in an informal way, what science and technology can and cannot do. The foundation of science centres in other industrialised countries, such as the United States and Japan, has been spurred on by the idea of counteracting similar swings there (*New Scientist*, vol 65, p 82).

May I urge caution, however, because as radical reform of museum displays occurs there is the danger of throwing out the baby with the Victorian bath water. I refer to the balance between two-dimensional and three-dimensional display material. Museums are about objects and real objects can stimulate the learning process enormously. The "object lesson" of 100 years ago has fallen out of favour, regrettably, for science education in school. However, one has only to look at the queues of people waiting to see Moon rock, or the treasures of Tutankhamen, for evidence of the ability of objects to arouse interest. It would be excellent if the public could be allowed to handle the less valuable objects. Then the object could be placed in its scientific context by displays etc, which use the communication skills of modern designs and educationalists.

THE VIKINGS FEEL FREE TO HANDLE THE EXHIBITS

The Natural History Museum has gone a good way towards the end. But why not allow a greater freedom of interaction between the public and the real object? There are signs of the dawning of a Brave New World in museums. I for one am looking forward to the "feelies".
B. D. Sorsby *Ormskirk*

Schizophrenia

As a scientist and schizophrenic I was most interested in Dr David Horrobin's article, "A singular solution for schizophrenia" (28 February, p 642).

I have had two major bouts of this illness both initiated by extreme psychological stress. I have since attempted in my occupation to avoid major stress and have been trouble-free for the past seven years.

I believe schizophrenia to be a physicochemical problem but that it requires a trigger. Therefore I object to the statement in the article: "If schizophrenia is a physicochemical problem, then talking to a schizophrenic and creating a congenial home and working environment are going to be about as valuable as they would for a diabetic who requires insulin."

I believe a congenial environment to be most important for a schizophrenic, at least after return to near "normality". It is like insulin for a diabetic—a treatment, not a cure.
R. D. Bradley *Calne*

Dr Horrobin's interesting point that the congenitally blind may not develop schizophrenia because light inhibits the output of melatonin leads to the further, interesting, and seasonal, point that most "sane" people feel rather crazier in the spring. Could this be because of the sudden increase in light, which we presumably acquire tolerance of as the year wears on? This would of course apply to only parts of the world where there is a seasonal variation in light. But it might also have some application to visual artists (such as Van Gogh) who possessed a particular sensitivity to light values. Is there any seasonal weighting in light-variable latitudes to the onset of schizophrenia: among individuals "on the brink", who are pushed over that brink by the increase in light?
Ian Watson *Moreton Pinkney*
PS Is this why neurotics wear sunglasses?

Yet another sick cover. That for 28 February "Schizophrenia—a singular solution" is a nice (sic) illustration of how obscenity can be achieved:

1. Take something intrinsically rich in meaning such as a human face (or human sexuality).
2. Degrade it (ie systematically emphasise the parts at the expense of the whole or, better still, wound it).
3. Use your intelligence to pervert it further (don't just rot it down, but twist your imaginative powers in the enterprise).
4. When challenged come up with a phoney excuse for fouling a public place ("we only did it to shock you!") You did.

Robin A. Hodgkin *Falmouth*

We welcome comments from our readers, who should write to the Letters Editor, *New Scientist*, King's Reach Tower, Stamford Street, London SE1 9LS. Short communications stand the best chance of publication and the Editor reserves the right to take extracts from the longer ones.

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APPOINTMENTS AND SITUATIONS VACANT

FOOD SCIENTIST QUALITY CONTROL

HERTFORDSHIRE

We are a progressive multi-national company, makers of Ovaltine and a growing range of other quality grocery products.

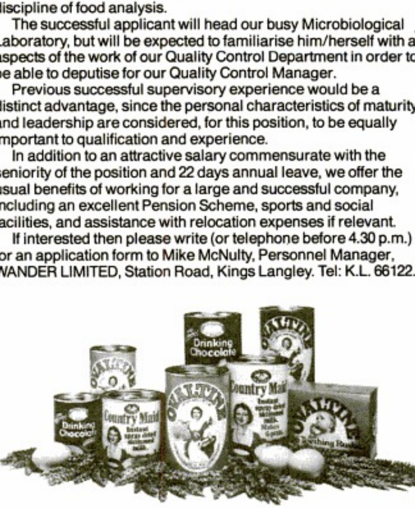
We now wish to fill a key vacancy within our Quality Control team with a Food Scientist, (either a graduate or a person qualified to equivalent level through the examinations of a relevant professional institute), with some years experience of Quality Control in a process industry, preferably foods but possibly pharmaceutical. The ideal candidate will have a microbiological bias but must also be fully conversant with the discipline of food analysis.

The successful applicant will head our busy Microbiological Laboratory, but will be expected to familiarise him/herself with all aspects of the work of our Quality Control Department in order to be able to deputise for our Quality Control Manager.

Previous successful supervisory experience would be a distinct advantage, since the personal characteristics of maturity and leadership are considered, for this position, to be equally important to qualification and experience.

In addition to an attractive salary commensurate with the seniority of the position and 22 days annual leave, we offer the usual benefits of working for a large and successful company, including an excellent Pension Scheme, sports and social facilities, and assistance with relocation expenses if relevant.

If interested then please write (or telephone before 4.30 p.m.) for an application form to Mike McNulty, Personnel Manager, WANDER LIMITED, Station Road, Kings Langley. Tel: K.L. 66122.



2 POSITIONS IN APPLIED PHYSICS

The Department of Physics at Arizona State University invites applications for two tenure-track positions in applied physics. Persons selected will help to develop an academic program in the area, establish co-operative research programs with local electronics industry and assist in teaching appropriate courses. Preference will be given to persons with research interests in the general areas of electronic materials and the interactions of radiation with matter. Postdoctoral experience with proven research record is required. Initial appointment will be at the assistant professor level. Applications from women and minority groups are particularly solicited. Applicants should submit a *curriculum vitae*, list of publications, a resume of research experience and three letters of recommendation to: **Search Committee for Applied Physics, Department of Physics, Arizona State University, Tempe, Arizona 85281.** The closing date is 15 April, 1980. Arizona State University is an affirmative action/equal opportunity employer.

GREATER GLASGOW HEALTH BOARD EASTERN DISTRICT

Glasgow Royal Infirmary—Centre for Respiratory Investigation

SCIENTIST

Required for physiological work in the service and development aspects of a specialised pulmonary function assessment service.

Qualifications required—Honours degree, probably in physiology. Experience of pulmonary physiology not essential but computing experience would be an advantage.

Salary in accordance with Whitley Council scales for biochemist/scientist. Further information from Dr F. Moran. Tel: 041-552 3535 ext 278. Application form and job description available from the District Administrator, Greater Glasgow Health Board, Eastern District, 13 Bath Street, Glasgow G2 1JB to whom completed applications should be returned not later than 31 March, 1980.

BRUNEL UNIVERSITY

Uxbridge, Middlesex

POST DOCTORAL RESEARCH FELLOW—CELL BIOLOGY

A Post-Doctoral Research Fellowship is available for three years, commencing as soon as possible, for work on macrophage activation and tissue destruction in inflammatory processes. The project will involve work on hydrolase secretion, cartilage degradation, and pinocytosis and will be directed by Dr Roger Dean, Reader in Biology.

Salary commencing £7139 (April Interim, including London Allowance).

Applications should be made to Dr Dean at the address above by 31 March, 1980 and should include a curriculum vitae and any recent publications.

Communications Consultants to £13,000

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Since its formation in 1969, Logica has grown to become one of Europe's leading consultancies in computing and communications. As part of our planned growth, we are shortly opening an Advanced Technology Centre in a country house at Cobham, Surrey.

We believe the site provides an exceptionally attractive alternative to our Central London offices. It will appeal to those who prefer a rural setting for creative work. We plan to base a number of exciting projects there.

Cobham is 10 miles NE of Guildford, just off the A3.

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We are keen to recruit staff who can contribute to developments particularly in Energy, Aerospace and Defence.

Our projects require all grades of staff with demonstrable achievement in one or more of the following areas:

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If you find your present environment restrictive, you will find Logica invigorating, challenging and rewarding. You will be working among other professionals with a high level of achievement and you will be encouraged to develop your abilities and experience.

To explore the possibility of joining us, call Julia Roth on 01-637 9111 or write to her for an application form, quoting reference TG/14, at

Logica Limited
64 Newman Street
London W1A 4SE.

Business Analyst for High Technology Industry

This is an excellent career opportunity for a young MBA Technical graduate or an Accountant familiar with a business planning environment.

We're looking for someone, male or female, to help formulate and develop, in conjunction with senior management, resource plans to meet the objectives of one of the world's top engineering based organisations. The successful candidate will also be responsible for monitoring actual performance against that planned, and working closely with functional managers to clearly identify, articulate and resolve any variances that may arise.

To join us you'll need to be strongly self-motivated, and with an ability to communicate effectively at all levels and across disciplines, and have had at least two years' experience in a well developed analytical environment.

If you can meet our requirements you'll find yourself part of a top professional team where ability and talent are recognised and rewarded, and where career development is both positive and planned.

We're offering a competitive salary around £7,500 and an excellent benefits package. If you have to move house, you'll find that we can offer generous assistance with relocation, including subsistence and travelling expenses for the period prior to moving. There is a very active sports and social club which includes sailing and squash. The job is located at Welwyn Garden City.

For an application form and information package, please telephone or write to Suzy Johnson, Rank Xerox Engineering Group, Bessemer Road, Welwyn Garden City, Hertfordshire AL7 1HE. Telephone: Welwyn Garden City 35794.

RANK XEROX
ENGINEERING GROUP

UNIVERSITY OF LEICESTER
Department of Anatomy
TECHNICIAN

Applications are invited for the post of Technician Grade 6 in the Histology Unit of the Department of Anatomy, catering for Teaching and Research needs within the Department. The successful applicant should be conversant with all routine histological techniques and have experience in histochemistry. A knowledge of methacrylate sectioning, autoradiography and photomicroscopy would be an advantage.

Qualifications should include HNC or equivalent and the background experience concommitant with a senior technical post.

Salary on the Grade 6 scale £4584-£5475 a year. (From 1 April, 1980 £4884-£5832 a year.)

Applications giving the names of two referees to A. R. Roper, Senior Assistant Registrar, University of Leicester, University Road, Leicester LE1 7RH by 21 March, 1980.

HILL FARMING RESEARCH ORGANISATION

SCIENTIFIC OFFICER

Applications are invited for a Scientific Officer who will join a small team who are carrying out research into the factors controlling changes in body composition of hill and upland sheep in various stages of physiological states, including growth, pregnancy and lactation. Particular emphasis is placed on investigation of the endocrine mechanisms through which nutritional, climatic and other factors may operate.

Previous experience in working with animals, collection and processing of blood and faeces samples, carcase dissection, data collection and processing and hormone concentration determinations by radioimmunossay would be advantageous.

Qualifications: A degree, HNC, or equivalent, in a Scientific or Mathematical subject.

Salary: According to qualifications and relevant experience within the scale £3591—£5486.

Other conditions: Non-contributory superannuation scheme. 20 days annual leave.

Further particulars and application forms from the **Secretary, Hill Farming Research Organisation, Bush Estate, Penicuik, Midlothian EH26 0PY.** Reference A/6/247 and closing date 5 April 1980.

RESEARCH ADMINISTRATION—SOCIAL SCIENCE RESEARCH COUNCIL
SENIOR SCIENTIFIC OFFICER—RESEARCH RESOURCES GROUP

£7112-£9485

The Social Science Research Council is a Government-funded organisation whose Headquarters staff of 162 are all engaged in administration. It requires a Secretary to the Computing Committee and a number of associated working groups and panels concerned with the methodology in the Research Resources Group.

Applicants should be at least 27, have a good degree and have experience of computing facilities and problems, more especially in the social science field. Knowledge and experience of Social Surveys would be a distinct advantage.

The salary scale, which is under review, is £7112-£9485 (including London Weighting). Starting salary may be above the minimum, depending upon experience and qualifications.

Application forms and further details may be obtained from Mrs V. Bishton (ref: SSO/NS), Social Science Research Council, 1 Temple Avenue, London EC4Y 0BD. Tel: 01-353 5252 ext 110. Closing date: 27 March, 1980.

UNIVERSITY OF SALFORD
DEPARTMENT OF CHEMISTRY & APPLIED CHEMISTRY

TECHNICIAN
(Grade 5)

An experienced and well qualified technician for an interesting post assisting the Analytical Sciences Research Group. Candidates ideally should be adept in the design and fabrication of special analytical instrumentation with emphasis on the electronic aspect.

Qualifications: City and Guilds Advanced Certificate, HNC (Chemistry), LRIC or recognised equivalent

Excellent working conditions with pension scheme and 21 days annual leave plus 13 public/customary holidays.

Opportunities exist for suitable candidates to pursue research work leading to higher qualifications.

Salary scale: £3996—£4666 (£4257—£4974 from 1.4.80).

Letters of application stating age, qualifications and experience, together with the names and addresses of two referees, should be sent to the Registrar, University of Salford, Salford M5 4WT by 18 March 1980, quoting reference number CH/275./NS

UNIVERSITY OF LEEDS
TWO GRADE 5 TECHNICIANS

required in the research section of the Organic Chemistry Department.

Post A is principally to provide a gas Chromatography service to the department but responsibility will also include some UV spectroscopy and micro-separation techniques.

Post B is for a person to synthesise organic intermediates to be used for both research and teaching purposes and also to assist in the running of the research laboratories.

Candidates must be qualified to a minimum of HNC standard and have at least eight years experience. Salary on interim scale £4257-£4974. Applications, giving full details of age, experience and qualifications, to Mr J. M. Beeley, School of Chemistry, The University, Leeds LS2 9JT.

TRANSLATORS

Wanted, scientific, technical and medical translators from Swedish, Russian, German and French, for academic publisher. Write in confidence with qualifications, experience, etc, to Box no D470.

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ASSOCIATED NUCLEAR SERVICES, an independent firm of Consulting Engineers, is expanding rapidly and has vacancies for experienced and versatile professional engineers to participate in consultancy work on large projects in the nuclear, offshore and process industries.

Particular fields of work include safety engineering, reliability engineering and examination and auditing of systems used for management of complex engineering projects. Work is also available for engineers with specialised interest in stress analysis, fluid motion, heat transfer and transient analysis.

Initial appointments will be in the range £6000 to £10 000 per annum, depending on qualifications and experience, with opportunities for advancement.

The ANS offices are in Epsom, conveniently situated for public transport. Conditions of employment include a contributory pension scheme and free life and accident insurance. Assistance with relocation expenses will be given where appropriate.

Applicants should telephone or write for an application form to **Mrs G. Dorrington, Associated Nuclear Services, 123 High Street, Epsom, Surrey. Telephone Epsom (STD 03727) 40531.**

KINGSTON POLYTECHNIC
School of Electronic
Engineering and Computer Science

Senior Research post in

NUMERICAL ANALYSIS AND SOFTWARE DEVELOPMENT FOR CONTROL SYSTEMS

A person with Fortran programming experience and a strong background in numerical analysis and/or control systems is required to take up a senior position in a small group developing software and carrying out numerical analysis research in the control systems field. The project is supported by the SRC through its Interactive Computing Facility and the software developed is intended to support research workers in this field throughout the UK, Europe and the USA in order to maintain close contact with other major groups developing software in this field. The post is suitable for someone who has recently completed, or is about to complete this year, an MSc or PhD course in Numerical Analysis, Control Systems, or Computer Science.

Salary in range up to £7017 pa (under review) depending on qualifications and experience.

Further details and application forms from **Assistant Registrar (Personnel), Kingston Polytechnic, Penrhyn Road, Kingston upon Thames KT1 2EE. 01-549 1366.**

EASTER HOLIDAY COPY DEADLINES

Would advertisers please note that classified copy deadlines for the issues of the 3 and 10 April will be as follows:

Issue Date	Deadline
3 April	11 am Friday 28 March
10 April	11 am Thursday 3 April

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

Assistant Librarian

Library & Information Section

Winfrith, Dorset

The Atomic Energy Establishment, Winfrith, is a major centre for research and development in support of the United Kingdom's nuclear power programme. There are 1,800 staff, of whom one quarter are professional Scientists and Engineers. The Library and Information needs of the site are served by a Central Special Library in which there is a vacancy for an Assistant Librarian.

Duties:

To be responsible to the Winfrith Librarian for the efficient operation of the Library General Office, Reading Room, and Reports Section. This will include stock maintenance and storage, ordering and cataloguing of library stock accessions, loan procurement and issues and the supervision of staff working in these areas. The duties will also involve working with the Librarian on improvements to the existing services, and training of junior staff.

Qualifications and Experience:

Applicants should be Associates of the Library Association or have a Degree or Diploma in Librarianship or hold a post-graduate qualification in Librarianship. They should have had experience in a Scientific or Technical Library, including staff management. Background experience in engineering or one of the physical sciences would be advantageous.

Rate of Pay: The appointment will be in the Scientific Officer grade. The present scale, from 1st January 1980, is £3,845 per annum rising by annual increments to £5,875 per annum, the starting salary depending upon age, qualifications and experience.

Housing:

Housing or assistance with house purchase will be available to a married officer living beyond daily travelling distance.

Applications to:

Appointments Officer 'A', Personnel Branch,
AEE Winfrith, FREEPOST, Dorchester,
Dorset. DT2 8DH (no postage stamp necessary).
Telephone Dorchester (0305) 3111 Extn. 3049.
(Reference WA 315).

Winfrith

APPOINTMENTS IN AGRICULTURAL RESEARCH

Our Agrochemical research programme involves extensive investigation and analysis of residues from new crop protection and animal husbandry compounds and of the results of soil/pesticide interactions. Two further appointments are to be made:–

A CHEMIST

to lead an established team at our Nottingham research laboratories developing procedures for the analysis of these residues from new products which have potential use in agriculture. Submission of written reports on the team's findings and liaison with other scientific personnel is an essential feature of the work.

Applicants must hold a good honours degree in chemistry or related subject with relevant research experience to at least Ph.D level. Post doctoral experience would be an advantage.

A BIOCHEMIST/MICROBIOLOGIST

to join a small team engaged in soil studies which use standard analytical techniques to investigate the interfacial problems of soils and pesticides.

Applicants should have an appropriate honours degree and post graduate experience in soil microbiology or related environmental science.

Salaries will be competitive and Company benefits include profit sharing and staff purchase privileges. Generous help with relocation to the Nottingham area is available, if applicable.

Please write or telephone for an application form stating which position interests you, Tom Flower, Employment Manager (Technical), The Boots Company Ltd., Station Street, Nottingham NG2 3AA. Nottingham 56255 Ext. 243.

UNIVERSITY OF EAST ANGLIA

Norwich

Applications are invited for the post of

POST-DOCTORAL RESEARCH ASSOCIATE

in the Schools of Chemical and Biological Sciences, to work with Dr A. J. Thomson and Dr C. Greenwood on the magnetic circular dichroism and optical double magnetic resonance spectroscopy of metallo-proteins. Previous experience in any of the fields of transition-metal spectroscopy, magnetic circular dichroism, electron paramagnetic resonance, microwave spectroscopy or metallproteins is desirable. The post, which is available from October 1980, is for one year, in the first instance. Salary on the Research and Analogous 1A scale £5052-£8769 per annum.

Application, together with a curriculum vitae and the names and addresses of two referees, should be sent either to Dr A. J. Thomson, School of Chemical Sciences or to Dr C. Greenwood, School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ.

TECHNICAL LABORATORY SERVICES LTD., who provide a comprehensive pathology service to the private sector of medicine, require a Medical Laboratory Scientific Officer/Junior Medical Laboratory Scientific Officer to work in their rapidly expanding Radioimmunoassay Department. Salary will be negotiable, and will depend on experience and interest in the field of radioimmunoassay. For further information please contact Mr D Yeoman, telephone 01-606 0687.

Applications, in writing please, to The Laboratory Manager, Technical Laboratory Services Ltd., 48-50 Bartholomew Close, London EC1.

SENIOR ANIMAL TECHNICIAN

Applications are invited for the position of Senior Animal Technician with minimum Intermediate IAT qualification.

Very interesting and busy work concerned with toxicology—wide variety of animals in Laboratories situated in London NW10.

Salary in the region of £3800—£4500 negotiable, according to age, experience and qualifications, and subject to a three month review.

Applications in writing please to

Mr R. J. Hamilton-Bruce, I.C.I.S. Laboratories Ltd., 188 Brent Crescent, LONDON NW10 7XT

or telephone 01 965 1157 for further information and interview arrangements.

NATURAL HISTORY MUSEUM
SOUTH KENSINGTON

ASSISTANT SCIENTIFIC OFFICERS

Applications are invited to fill current vacancies in the Department of Palaeontology at South Kensington and in the Department of Mineralogy at South Ruislip (Victoria Road). Applications are also invited for future vacancies in the Departments of Zoology, Entomology, Botany and Mineralogy, all at South Kensington.

Minimum qualifications: four passes in GCE 'O' level or equivalent including English language and a science or mathematical subject. Age normally under 26 on 31 December 1980.

Salary: £2112 pa (age 16) to £3082 pa (age 20) rising by annual increments to £4030 pa. In addition, posts at South Kensington attract £780 pa Inner London Weighting and the post at South Ruislip, £325 pa Outer London Weighting. Prospects of promotion.

Application forms from **Mrs Helen Clovey, British Museum (Natural History), Cromwell Road, London SW7 5BD. Telephone: 01-589 6323 Ext. 441.**

Closing date for receipt of application forms: **3 April, 1980.**

AGRICULTURAL RESEARCH COUNCIL

Food Research Institute

Chemistry & Biochemistry Division

(Physical Methods Group)

SCIENTIFIC OFFICERS

The Food Research Institute has two vacancies in the recently created Physical Methods Group whose objective is to relate the molecular properties of proteins and polysaccharides to the texture and rheology of food products.

New and powerful techniques, including photon correlation spectroscopy, electric birefringence and solid-state NMR spectroscopy, are being developed in these studies.

Applications are now invited from persons interested in the use of modern physical methods to join the two teams in the Group at an early stage of their research programme.

The posts available are:

Biophysicist/Physical Chemist— Ref: 79/12

Physicist/Physical Chemist— Ref: 79/10

Qualifications: Candidates should have, or expect to obtain, a First or Upper Second Class Honours degree in Physics, Chemistry or Biochemistry.

Previous experience in surface chemistry, spectroscopy or the use of physical methods in biology would be an advantage but not essential.

Salary on a scale £3591-£5486.

Five day working week and flexible working hours scheme operated.

Further particulars and application form from the Secretary, Food Research Institute, Colney Lane, Norwich NR4 7UA quoting the appropriate reference. Closing date: 1 April, 1980.

UNIVERSITY OF HULL

Department of Computer Studies

Applications are invited for the post of

LECTURER IN COMPUTER STUDIES

Although applications are welcomed from well-qualified persons in any area of the subject, some preference may be shown to candidates with research and teaching experience in data processing and database methods or who wish to develop interests in these areas.

Salary scale: £5052-£10 484 per annum (from 1 April, 1980) plus USS benefits.

Applications (six copies) should give details of age, qualifications and experience, together with the names of three referees and be lodged not later than 14 April, 1980 with the Registrar, The University of Hull, Hull HU6 7RX from whom further particulars may be obtained.

UNIVERSITY OF YORK

BIOLOGY DEPARTMENT

A vacancy exists in the Biology Department Teaching Laboratories for a Technician to be responsible for the preparation of practical classes in Microbiology and Biochemistry and the development of class experiments.

Candidates should have seven-nine years' experience and appropriate advanced City and Guilds or equivalent qualifications.

Salary on Grade 4: £3707-£4266 (from 1 April: £3948-£4545 per annum).

Applications in writing with the names and addresses of two referees to the Laboratory Superintendent, Department of Biology, University of York, Heslington, York YO1 5DD by closing date 28 March, 1980.

General Pharmacology

Team Leader to £10,000+

This is an attractive and challenging appointment for a PhD pharmacologist with broadly-based drug research experience—to head up his/her own research team within the modern and well-equipped R & D Laboratories of a major international pharmaceutical company.

The General Pharmacology Team is responsible for investigating the broad pharmacological profile of a new compound, to complement the studies on its specific therapeutic potential carried out by other research groups.

In particular, the Team Leader will have responsibility for:

- Motivating, planning and supervising the work of a team of 3-4 pharmacologists.
- Detailed investigation of unusual and/or unanticipated pharmacological actions.
- Active co-operation with multidisciplinary project teams and other scientific Units.

The post calls for a scientist with wide knowledge of pharmacology, a strong practical bent, good leadership skills, and the ability to contribute ideas and co-operate effectively with scientists in other disciplines. Exisitng pharmaceutical industry experience would be highly desirable.

Conditions of service are good and, in addition to a starting salary which could exceed £10,000 (according to qualifications and experience), there are excellent bonus, pension and life assurance schemes. An added attraction is that the Research and Development Laboratories are located in a pleasant semi-rural part of England.

Please write in confidence for an application form, or 'phone if you would like to discuss the appointment further before applying:

Talentmark
Leaders in Health Care Recruitment

James A. Edwards, Talentmark Limited,
King House, 5-11 Westbourne Grove,
London W2 4UA. 01-229 2266 (24 hours)

UNIVERSITY OF SOUTHAMPTON

Human Vibration Research

ELECTRONICS ENGINEER

required to work on the development of a means of increasing the legibility of images on advanced head-mounted television displays in vibration environments.

The successful applicant will join a multidisciplinary Research Unit and be involved with experimentation on human subjects in a well-equipped motion simulation laboratory with extensive computing facilities.

Experience with analogue or digital control techniques would be an advantage.

Salary on range rising to £7000. USS superannuation benefits.

Applications (two copies), including a brief curriculum vitae and the names of two referees should be sent to D. A. S. Copland, The University, Southampton SO9 5NH, quoting reference 251/A/NS.

ANIMAL HEALTH TRUST
SMALL ANIMALS CENTRE

Applications are invited for the post of

RESEARCH TECHNICIAN

to work on a project concerned with an infectious eye disease in cattle. We are looking for a person who has a working knowledge of bacteriological identification and some experience of basic immunological techniques. Travel to herds distant from the laboratory will be involved and willingness to work with cattle is essential.

The position is tenable for three years from 1 April 1980. Salary £3158—£4092. Write for job description or send application with curriculum vitae to the Station Secretary, Animal Health Trust, Lanwades Park, Kennett, Newmarket, Suffolk CB8 7PN. Closing date for applications 28 March 1980.

South West Thames Regional Health Authority in co-operation with The University of Surrey....

.... offers two training posts with the opportunity to study for an

MSc in Clinical Biochemistry

by means of a two-year sandwich course commencing on 1 October 1980. Applicants should have or expect to obtain a good honours degree (or its equivalent) in Chemistry, Biochemistry, or other relevant biological science by that date. During the parts of the course spent away form the University, students will work in a specified hospital laboratory or laboratories in the Region.

Applications are invited from suitably qualified candidates already in NHS employment and from those wishing to enter the service. Probationary biochemists scale for new entrants: £4464 or £3807 per annum depending on qualifications, rising by annual increments, and where appropriate, London Weighting Allowance £398 or £141 per annum, in-service applicants may retain their current terms and conditions of service. Students will be responsible for meeting the cost of University and membership fees.

Further details and application forms available from the Academic Registrar, University of Surrey, Guildford, Surrey GU2 5XH.

Closing date for applications is Thursday 3 April 1980.

LEONARD WILLS FIELD CENTRE

requires responsible

ASSISTANT COOK

Residential preferred. Hours 0730-1300 and 1700-2000. Five day week. Must be prepared to work weekends. References required. Please apply to The Warden, Nettlecombe Court, Williton, Taunton, Somerset TA4 4HT (Washford 320).

UNIVERSITY OF BRISTOL

RESEARCH POST

An opportunity for novel and varied experimental work on defects in diamonds including development of cathodeluminescence spectroscopic apparatus and experiments by X-ray topography and electron microscopy. Salary appropriate to age and experience.

Contact Professor A. R. Lang, FRS, H. H. Wills Physics Laboratory, Bristol BS8 1TL.

UNIVERSITY COLLEGE LONDON

Department of Anatomy and Embryology

RESEARCH ASSISTANTS

required by Professor G. Burnstock to participate in research on the Autonomic Nervous System. Experience in pharmacology, electrophysiology, electronmicroscopy, histo-chemistry or neurochemistry an advantage. Two positions are available, one for work related to diabetic neuropathy and the second for work relating to purinergic nerves and receptors. Both positions are grant funded for up to three years. Salaries in range £5199-£5777 or £5389-£6062; plus £740 London Allowance. Applications together with names and addresses of three referees to Professor G. Burnstock, Department of Anatomy & Embryology, University College London, Gower St, London WC1E 6BT.

THE CITY UNIVERSITY

Department of Optometry & Visual Science

TECHNICIAN GRADE 4

For duties including circuit construction for research and assistance in routine teaching laboratories, including student projects.

Candidates should be experienced in Electronics, with an interest in microprocessors, and have completed (or be studying for) a certificate in an appropriate course.

Salary will be in the range £4728-£5325 inclusive.

To apply please contact Ms Jane Cameron, Personnel Recruitment Assistant, The Personnel Office, The City University, Northampton Square, London EC1V 0HB. Tel: 250 1107 (ansaphone).

Opportunities in Ministry of Defence

Computer Scientist

Institute of Naval Medicine,
Alverstoke, Gosport, Hants

. . . to be responsible within the Statistics Section for operating and developing the use of the terminal link to an ICL 1904S computer, the Wang System 2200B, and the Data General Eclipse Systems. It will be essential to develop and acquire software and hardware for processing batch and on-line data from medical trials and surveys. The successful candidate will provide programming support to scientists in medical and related fields, particularly during experimental trials.

Candidates should have an Hons degree or equivalent in a relevant subject, and programming experience including a good working knowledge of FORTRAN. Appointments as Higher Scientific Officer or Scientific Officer according to qualifications and experience. Ref SA/8/EG.

Computer Scientist

Institute of Naval Medicine,
Alverstoke, Gosport, Hants
Naval Radiological Protection Service

. . . to provide support to marine environmental radioactivity monitoring surveys. The work will involve maintaining and developing computer software, assisting with radioactivity counting problems maintaining data bank for radioactivity source holdings and waste disposals reported by other MOD Establishments and recommending improvements in computer procedures and equipment.

Candidates should have a Degree/HND/HNC in a relevant subject and a working knowledge of FORTRAN. Appointment as Scientific Officer. Ref: SA/9/EG.

Vibration Data Analysts/Engineers

Naval Aircraft Materials Laboratory,
Gosport, Hants

. . . to lead/join a section developing new vibration analysis techniques for detection and diagnosis of faults in rotating assemblies (helicopter rotor systems, gear boxes and gas turbines). The work will include extraction of vibration data from these assemblies in their working environments, data analysis using a dedicated PDP 11-60 computer, and close liaison with university and other research organisations.

Candidates should have a degree or equivalent in an appropriate scientific/engineering discipline; the team leader should have a good honours degree and at least 2 years' post-graduate experience including digital signal processing. Experience in the study of vibration in rotating assemblies or use of mini-computers would be advantageous.

Appointments as Higher Scientific Officer (teamleader) or Scientific Officer. Ref: SA/3/EJ.

Paint Technologist

Materials Quality Assurance Directorate,
Woolwich, London SE18

. . . to examine paints, varnishes and allied products to ensure compliance with Service specifications. This will involve evaluating prospective coatings using environmental and physical test methods, determining test limits for new specifications arising from experimental work and providing technical advice on paint and painting.

Candidates should have a Degree/HND/HNC or equivalent in chemistry, materials science or related discipline and at least 2 years' experience in the paint industry. Appointment as Higher Scientific Officer. Ref: SA/14/FW.

Application forms from Specialist Personnel and Training Officer, MOD, Materials Quality Assurance Directorate, Building E135/1, Royal Arsenal East, London SE18 6TD.

Applied Physicist/ Materials Scientist

Atomic Weapons Research Establishment,
Aldermaston, Berks

. . . to be responsible for the fabrication, assembly and alignment of complex multishell and multilayer laser targets. The successful candidate will develop micromanipulating and optical microscopic techniques and supervise laboratory staff.

Candidates should have a Degree/HND/HNC or equivalent in physics or materials science. At least 2 years' post-graduate experience essential. Appointment as Higher Scientific Officer. Ref: SA/16/FKA.

Data Processing Section Manager

Royal Artillery Range, Benbecula,
Western Isles

. . . to be responsible for the general management and supervision of the DP section. The work involves post flight analysis of missiles, estimating splash point and analysing results from radars tracking missiles, discussing new software with contractors and advising on DP requirements. In addition, the successful candidate will specify and design new software to cover the introduction of new weapon systems, targets, range instrumentations and off line data processing of firing results.

Candidates should have a Degree/HND/HNC or equivalent in a relevant subject. At least 2 years' relevant post-graduate experience essential. Appointment as Higher Scientific Officer. Accommodation available. Ref: SA/1/FAG.

SALARY (under review): HSO £5095–£6735; SO £3590–£5485 (up to £780 higher in London). Age normally under 30. Promotion prospects. Non-contributory pension scheme.

Unless otherwise stated application forms (for return by 9 April, 1980) from Ministry of Defence, CM(S) 1b3, Room 310, Savoy Hill House, Savoy Hill, London WC2R 0BX. **Please quote appropriate reference.**

Scientific Civil Service

Opportunities in Ministry of Defence

Chemist

Naval Aircraft Materials Laboratory

. . . to join a section providing scientific advice and support to the Fleet Air Arm and Naval Aircraft Repair Organisation on problems relating to a wide range of non-metallic materials. This will involve planning and carrying out 'trouble-shooting' investigations, preparing brief, lucid reports, and analysing polymers, paints, lubricants and other materials.

Candidates should have a Degree/HND/HNC in chemistry. Experience of gas chromatographs, atomic absorption, and infta-red spectrophotometers desirable. Appointment as Scientific Officer. Ref: SA/4/EJ.

Computer Scientist

School of Signals,
Blandford Camp, Dorset

. . . to provide software support to a message switching system. This will involve responsibility for advising on testing and implementing software changes to the existing system and ensuring that user requirements are met.

Candidates should have a Degree/HND/HNC in a relevant subject and at least 2 years' post-graduate experience. A knowledeg of real time systems and design of computer based communication systems advantageous. Appointment as Higher Scientific Officer. Ref: SA/2/EW.

SALARY (under review): HSO £5095–£6735; SO £3590–£5485 (up to £780 higher in London). Age normally under 30. Promotion prospects. Non-contributory pension scheme.

Unless otherwise stated application forms (for return by 9 April 1980) from Ministry of Defence, CM(S) 1b3, Room 310, Savoy Hill House, Savoy Hill, London WC2R 0BX. **Please quote appropriate reference.**

Scientific Civil Service

LOOKING FOR A CAREER IN FISH FARMING?

We are looking for a person with a degree in either biology or zoology (although this on its own is of minor importance) to train in modern intensive fish farming technology. For those with the right drive and initiative, the job could offer a position within farm management after a year of training. This is a position for a hard-working, dedicated person prepared to suffer the discomforts of long work hours and cold limbs in order to make a future in a new agricultural industry. Fish farming is concerned with wet cold fish, gilling and gutting, unloading lorries and carrying feedstuffs, cleaning fattening units, picking eggs, acting in sales, driving delivery vans, accounting for large sums of money, and wearing wellies, perhaps nine or ten hours a day. If this appeals to you, then please write, sending a recent photograph with cv. Closing date for applications, 22 March, 1980.

Field, Stream & Covert (England) Limited, Fish Farming Managers and Engineers, Meriden, Warwickshire CV7 7LJ.

Development Chemist

HAVERHILL, SUFFOLK

Hopkin and Williams, part of Baird and Tatlock (London) Ltd. is a prominent manufacturer of high purity chemicals for industrial, educational and medical establishments throughout the world.

We require a Development Chemist for our Production Unit at Haverhill, to undertake laboratory-scale organic and inorganic syntheses directed towards the development of manufacturing processes.

The job also entails the investigation of technical problems and active participation in plant trials.

Applicants with a degree in Chemistry and at least two years relevant experience should apply in writing with a detailed c.v. to:-

Mr. R. A. Jennings, Baird & Tatlock (London) Ltd., Freshwater Road, Romford, Essex, RM1 1HA.

MRC IMMUNOCHEMISTRY UNIT

MRC NON-CLINICAL SCIENTIFIC STAFF

The Council invites applications from suitably qualified research scientists for two appointments in the MRC Immunochemistry Unit. The Unit's research is mainly concerned with the structure of complement components, their activation by antibody-antigen aggregates, and with their interaction with cell surfaces.

For the first post, applicants should be biochemists with experience and interest in liquid and solid phase sequenators high-pressure liquid chromatography and other relevant techniques of protein chemistry. Applicants should also have worked with proteolytic enzymes and the biochemistry of complement proteins.

For the second post, applicants should be biochemists experienced in the investigation of the structure and activation of complement components.

Salary according to qualifications and experience.

Applications including curriculum vitae, a list of publications and the names of three referees should be sent to Professor R. R. Porter, MRC Immunochemistry Unit, University Department of Biochemistry, South Parks Road, Oxford OX1 3QU, by 12 April, 1980.

SOUTHERN ILLINOIS UNIVERSITY AT CARBONDALE

TEACHING ASSISTANTSHIPS

and a number of fellowships for autumn 1980 are available to qualified students who wish to pursue a programme leading to a master's degree in Physics or the PhD in Molecular Science. Areas of active research in theoretical and experimental physics include: nuclear theory, electrodynamics (especially of laser-matter interactions), group theory applications, atomic and molecular physics, statistical mechanics; far infra-red and laser-raman spectroscopy, Mössbauer spectroscopy, mass spectrometry, laser-induced chemical reactions, pulsed and CW NMR spectroscopy (including C-13), acoustics, thin films in liquid helium. Excellent research library and computer facilities are available. For further details contact: Dr Richard E. Watson, Chairman, Department of Physics and Astronomy, Southern Illinois University at Carbondale, Carbondale, Illinois 62901.

The Middlesex Hospital
Medical School
(University of London)
London W1P 7PN

Institute of Nuclear Medicine

Sub-Department of Molecular Biophysics,
Supraregional Assay Service (Hormone)
Laboratory

WHO Collaborating Centre for Research and Reference Services in the Immunoassay of Hormones in Human Reproduction

SENIOR LECTURER

Applications are invited from suitably qualified candidates for the above new post which arises from a restructuring of the staff of the SAS (Hormone) Laboratory. The successful candidate will be responsible for the day-to-day organisation and technical performance of the hormone assay services in collaboration with the Sub-Departmental Senior Lecturer (Clinical). The appointee will also be expected to integrate with other groups within the Sub-Department and the School currently developing new immunoassay methodologies and will have the opportunity of participating in academic research projects, undergraduate and postgraduate teaching, and in the immunoassay courses centred on the Sub-Department in fulfilment of its role as an SAS and WHO Collaborating Laboratory.

The post requires technical experience in the field of radioimmunoassay, organisational and managerial ability, the capacity to pursue effective research and development in a highly competitive area, and an aptitude for teaching at a variety of levels. An appropriate Honorary NHS grading will be sought.

Salary, according to age and experience, within the range £10 308–£12 594 per annum inclusive of London Allowance (6% increase in basic scale from 1 April, 1980).

A job description is available from **Professor R. P. Ekins**, at the above address to whom applications including the names and addresses of 3 referees should be sent by **16 April, 1980.**

Brewing Quality Control

SENIOR TECHNICIAN

CHARLES WELLS LTD BEDFORD

An experienced and responsible person is required to undertake and supervise a wide range of analyses in the brewing and packaging laboratories of the most modern private brewery in the country. The successful applicant will report directly to the chief chemist.

Applicants should have HNC or equivalent in chemistry or applied biology plus at least three years industrial experience.

Salary will be up to £5000 (depending on qualifications and experience). There are 20 days leave per annum plus generous fringe benefits including contributory pension. Accommodation may be available if required. Applications giving full personal details including current salary should be sent to: **J. C. Cinnamond, Chief Chemist, Charles Wells Ltd., Bedford MK40 1QA.**

BRUNEL UNIVERSITY

Uxbridge, Middlesex

RESEARCH TECHNICIAN—CELL BIOLOGY

A Research Technician is required for three years, commencing as soon as possible.

The project, concerned with maintenance of cell culture and biochemical assays is to be directed by Dr Roger Dean, Reader in Biology.

Salary commencing £4582 (including London Allowance).

Applications should be made to Dr Dean at the address above by 31 March, 1980 and should include a curriculum vitae and other relevant particulars.

Manager, Patents and Trademarks

Pharmaceutical Industry

c.£20,000 pa+car

Our client, a major multinational pharmaceutical group, is searching for a key manager to head their Patents and Trademarks Department. The company spends many £millions each year on new product research and development, and, as a result, the Patents and Trademarks Department plays a crucial role in ensuring that all new and existing products reap maximum benefits for the company. The Department consists of a team of specialists, which is located in the Southern Home Counties.

We would like to discuss this role with candidates of outstanding ability who feel they have the stature to take on a job at this level. Experience in the filing and presentation of patents (preferably chemical/pharmaceutical) in the UK and overseas is a prime requirement. A science based degree plus CPA are the ideal educational requirements.

We will wish to assess your high analytical ability and see evidence of proven managerial experience.

To apply, either write or telephone for an application form. Please address your replies, which will be treated in the strictest confidence, to Geoffrey King, Managing Director, quoting reference PTM.

This position is open to both men and women.

Cambridge Recruitment Consultants

1a Rose Crescent, Cambridge CB2 3LL Telephone: 0223 311316

UNIVERSITY OF CAMBRIDGE

Department of Biochemistry

GRADUATE RESEARCH ASSISTANT

required to work for two years on an MRC funded project to investigate the role of mitochondria in the maintenance of cytosolic free calcium in lymphocytes in collaboration with Dr M. D. Brand. Applicants should have recently received or expect to receive a degree in Biochemistry or a related subject.

Salary from 1 April on scale £4402-£5052.

Starting date 1 April or a later date to be agreed.

Applicants should send their curriculum vitae and names of two referees to: Dr M. D. Brand, Department of Biochemistry, University of Cambridge, Tennis Court Road, Cambridge CB2 1QW.

ELECTRON MICROSCOPE TECHNICIAN (GRADE 5)

required in Plant Science Laboratories, University of Reading, to be responsible for maintenance and operation of well-equipped laboratory and to provide advice, assistance and training to microscope users. Facilities include Jeol 100B TEM, JSM 35R SEN, freeze etching and cryoscan accessories. Experience in wide range of preparative techniques and equipment maintenance essential. Salary in scale £3996-£4668 per annum (under review). Apply with names of two referees quoting ref: TS 83A to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.

UNIVERSITY OF SUSSEX

School of Biological Sciences

RESEARCH TECHNICIAN—GRADE 3

to work in the Biochemistry Group on a three year project supported by the British Diabetic Association. The work involves the investigation of biochemical alterations in mammalian carbohydrate metabolism during Diabetes mellitus and following treatment with insulin. Some experience with general biochemical techniques would be an advantage.

Minimum qualifications ONC or equivalent plus three years relevant experience. However applicants with less practical experience can apply but appointment would be made at a lower grade and salary.

Salary from 1 April, 1980 £3594-£4092 per annum (under review). Holidays 20 days per year plus University closures and Public Holidays.

Applications in writing to the Laboratory Superintendent, University of Sussex, School of Biological Sciences, Falmer, Brighton, Sussex BN1 9QG. (Please quote ref: FT/3/MAT.)

RESEARCH TECHNICIAN

for Department of Cancer Studies to work on a project involving tissue culture and biochemistry of normal and transformed liver cells. Experience in tissue culture an advantage. Qualifications ONC in Med Lab Sciences or equivalent. Salary scale £3372-£3840 per annum. Application form from Assistant Secretary, Personnel Office, University of Birmingham, PO Box 363, Birmingham B15 2TT. Ref: 450/d/80.

UNIVERSITY OF LEICESTER

Department of Physics

TECHNICIAN GRADE 5

is required to work in the X-ray Astronomy Group's Space Research Programme. Work will involve design, construction and operation of specialised high vacuum systems and development and construction of x-ray detectors.

Previous experience in precision mechanisms, small instrumentation development, or vacuum practice would be an advantage, and the person appointed would also be expected to be generally capable of working without close supervision in the Department's Mechanical Workshop.

Salary £4257-£4974. Further particulars may be obtained from the Manager of Space Projects, Department of Physics, University of Leicester, Leicester LE1 7RH, to whom applications, giving details of age, experience, and qualifications and the names of two referees, should be sent by 31 March, 1980.

UNIVERSITY OF OXFORD,

Clarendon Laboratory

RESEARCH ASSISTANTSHIP

A vacancy exists for a post-doctoral research assistant to work with Professor E. W. J. Mitchell on the development of neutron spectroscopy of condensed matter in the eV region.

The post will be for three years on the academically related research scales. Applications should be sent to Professor Mitchell at the Clarendon Laboratory by 31 March, 1980.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF PHYSICAL CHEMISTRY

Post Doctoral Research Fellows and Post Graduate Research Assistants I.C.I. Joint Research Scheme

Applications are invited for research posts to study the fundamentals of fabric, synthetic fibre and polymer flammability in the above Department. The work is to be undertaken in close collaboration with the Department of Textile Industries and with I.C.I. Fibres Division at Harrogate. The project, directed by Professor P Gray FRS, began during 1979. The programme is concerned with the thermal degradation and spontaneous ignition of polymers and fibres, and with induced ignition, diffusion flames and flame spread at surfaces, leading to new practical approaches to the production of synthetic materials of reduced flammability. Applicants may have either a chemistry, physics or engineering background; their previous experience should relate either to combustion chemistry or heat and mass transfer, but others would be considered. For appointment at Research Fellow level a PhD. degree is required. Appointments will be made for a fixed period of up to two years, from a date to be arranged; it is possible that a further fixed term contract may be available at the end of the period.

Salary at an appropriate point on either the IA (Research Fellow) scale (£5052—£8769) or the IB (Research Assistant) scale (£4402—£6399) for Research and Analogous Staff.

Preliminary enquiries about the post will be welcomed by Dr J. F. Griffiths, Department of Physical Chemistry (Telephone (0532) 31751 ext. 6087).

Application forms and further particulars may be obtained from the Registrar, The University of Leeds, Leeds LS2 9JT, quoting reference number 46/12/E. Applications should be submitted as soon as possible.

UNIVERSITY OF CAPE TOWN

DEAN OF THE FACULTY OF SCIENCE

The post of permanent full-time Dean of the Faculty of Science at the University of Cape Town will become vacant by the end of 1980 on the retirement of the present incumbent, Professor J. S. de Wet.

It is hoped that the new Dean will assume duty early in 1981, but the timing is flexible. We are seeking a scientist of distinction and standing who will be able to provide the necessary academic leadership. Interested persons should in the first instance contact **Professor C. von Holt, Chairman, Search Committee, Department of Biochemistry, University of Cape Town, Private Bag, Rondebosch 7700, South Africa.** Alternatively, we would welcome suggestions for suitable candidates from our colleagues in the academic community. The University's policy is not to discriminate in the appointment of staff or the selection of students on the grounds of sex, race, religion or colour. Further information on the implementation of this policy is obtainable from the Registrar.

Kent and Canterbury Hospital

Nuclear Medicine Technician

(M.P.T. Grade II)

This NEW post, the Senior of four Technicians, will be in technical charge of the day to day running of the Nuclear Medicine Department; will supervise two Grade IV Technicians and one student; and will be responsible to the Consultant in Charge. The Medical Physics Department has considerable involvement within this Unit and there will be close co-operation with the Physicists.

Equipment includes two IGE Gamma Cameras, a PDP8E based data acquisition, processing and display system (shortly to be replaced by a Gamma-II System) and a Link System data logger. The person appointed will supervise and participate in patient imaging, preparation and dispensing of radiopharmaceuticals, sample counting, quality control as well as assisting with research and development undertaken, in close co-operation with the Medical Physics Department, in this active unit.

Candidates require at least two years relevant experience as a Grade III technician.

Salary scale £5547–£6918 pa (according to experience). *Further information and job description from Dr F. M. Hall, Consultant in Nuclear Medicine (Canterbury* **66877** *ext.* **401**).

Written applications to Unit Administrator, Kent and Canterbury Hospital, Canterbury, Kent. Closing date: 27 March.

Canterbury
& Thanet
HEALTH DISTRICT

INDUSTRIAL WASTE OFFICER

(£4,644 - £6,060 p.a.)

The person appointed will be a member of a small multi-disciplinary team having responsibility for ensuring that all wastes arising or to be disposed of within the County are dealt with in a safe and environmentally satisfactory manner. Duties will include regular inspection of all waste disposal facilities within the County area to ensure that these are operated in compliance with licence conditions, and to check that licence conditions as issued are effective in meeting the requirements of the Control of Pollution Act, 1974. The officer will also be expected to assist in waste surveys and technical site investigations.

Candidates should be qualified to a degree standard in an appropriate life science, including chemistry, and hold a current driving licence. An essential car user allowance is payable.

Application forms, returnable by 31st March 1980, from the County Engineer, Merseyside County Council, Fourth Floor, Steers House, Canning Place, Liverpool L1 8JW (Tel: 051-227 5234 ext. 2512). Please quote ref. no 610 in all correspondence.

Merseyside
County Council

Nuclear Energy Board

An Bord Fuinnimh Nuicleigh

The Nuclear Energy Board was established to advise the Government on nuclear technology and to regulate and control activities in this field. In particular, it is responsible for the preparation and enforcement of safety codes and regulations and for establishing licensing procedures for nuclear power stations and for the use of radioactive substances and irradiating apparatus.

Head of Laboratory

The Board is establishing a Radiation Laboratory to support its regulatory activities in the field of radiation measurement and protection. The principal activities of the Laboratory will be:

a) **Personnel Dosimetry**
b) **Local Radiation Measurement**
c) **Environmental Surveys**
d) **Radiometric Analysis**

Applications are invited from suitably qualified candidates for the post of Head of Laboratory The minimum technical qualification required is an Honours Degree or its equivalent in one of the Physical Sciences or Engineering. About ten years' post-graduate experience in Health or Radiation Physics is essential and the successful candidate must have demonstrated considerable competence in laboratory operation.

This appointment will be made at Principal Scientific Officer level, for which the salary scale is £9,849-£11,437 p.a. This salary scale is associated with a contributory pension scheme and is currently under review.

Applications, including a curriculum vitae and the names of three referees, should be sent before 4 April 1980 to:

The Nuclear Energy Board,
20 Lower Hatch Street,
Dublin 2.
Tel: 01/766223-01/764375

Wine Chemist

PORTUGAL

Cockburns, part of the Harveys of Bristol Group, have been renowned for their high quality ports for almost two centuries. The Company's headquarters is at Oporto where a vacancy will shortly arise for a chemist to head up a small technical team.

The main job responsibilities are managing a very well equipped laboratory: the analysis of ports, brandies and table wines for stability, colour, strength, etc: quality control of bottling: technical involvement with the Company's wine treatment and wine making facilities in Oporto and in the Douro Valley. Active participation in viticultural and wine making research and development in the Company and with outside research establishments.

Candidates should be qualified to not less than H.N.C. standard in chemistry. Practical experience in a laboratory with wine or a related alcoholic beverage is desirable: also, some experience of tasting of food or beverage products for commercial purposes. Practical experience of quality control is an added qualification.

Comprehensive training of specialised laboratory techniques is available in Bristol.

This post carries a full range of employment benefits appropriate to an overseas appointment and a company car.

Telephone 0272 836161 or write for application form to:

Mr. B. J. Bedford
Personnel & Training Manager

HARVEYS OF BRISTOL
HARVEY HOUSE, WHITCHURCH LANE, BRISTOL BS99 7JE

ROYAL MILITARY COLLEGE OF SCIENCE
SHRIVENHAM, SWINDON, WILTSHIRE

Graduate Demonstrators in Chemistry and Metallurgy

Applications are invited for posts as Graduate Demonstrators in the Chemistry and Metallurgy Department of the College. The successful candidates will assist with laboratory teaching to degree and other courses, and undertake research leading to a higher degree (PhD).

The **CHEMISTRY** post will involve research in one of the following fields: the preparation of complexes of the platinum group of metals and an evaluation of their potential as catalysts, organic photochemistry, preparation and properties of magnetic oxides, electrochemistry or surface chemistry and lubrication. The **METALLURGY** post will be in the field of physical metallurgy, primarily using a new 120KV electron microscope, investigating the structure and deformation mechanisms of superplastic copper alloys and the effect of alloy additions on the heat treatment characteristics of zinc aluminium alloys.

The appointment would normally be for a period of three years as a Graduate Demonstrator on a salary scale of £4210 to £4496 and requires a first or second honours degree, or equivalent in Chemistry, Metallurgy, Materials Science or a related subject.

Application forms and further information may be obtained from the Civilian Admin Office, Royal Military College of Science, Shrivenham, Swindon, Wiltshire SN6 8LA. Telephone 0793-782551 Ext 421. Please quote reference HQ 120/208 and specify Chemistry or Metallurgy.
Closing date for applications 3 April, 1980.

Battelle Geneva Research Centres
Battelle-Institut e.V. Frankfurt
wish to engage a

RESEARCH SCIENTIST

to carry out projects in the field of:
Cement Chemistry, notably for
Glass Fibre Reinforced Cement, Cement Admixtures, Special Cements and Clinker Production.
Candidates should fulfil the following requirements:
- Educated to a PHD degree and preferably have some industrial experience
- Ability to acquire know how in other fields such as asbestos based materials
- Flexible and capable of working independently on a large variety of problems
- Languages: Fluent in English, French and German optional.

Battelle offers for suitable candidates:
- Good salaries and social benefits
- Opportunity to work with colleagues of various disciplines and nationalities
- Travel and contact with leading personalities in industry.

Please address applications, including curriculum vitae, photograph and salary requirements, to the **Personnel Manager, Battelle, 7 Route de Drize, CH-1227 Carouge/Geneva, Switzerland.**

NATIONAL UNIVERSITY OF LESOTHO

Applications are invited for the post of

LECTURER IN THE DEPARTMENT OF STATISTICS

Though previous teaching experience is considered important, work experience in applied statistics especially in relation to developing countries will be given serious consideration. Special consideration will also be given to candidates who can teach courses in demography. Candidates should hold a PhD or MA/MSc in Mathematical Statistics or Applied Statistics. Salary Scale: R5493-R7527 per annum (£1 sterling=R1·84). The British Government may supplement salary in range £1920-£3768 per annum (sterling) (reviewed annually and normally free of tax) plus associated benefits. Family passages; baggage allowance; gratuity or superannuation; education allowance; overseas leave; inducement allowance or supplementation. Detailed application (two copies) with curriculum vitae and naming three referees to be sent direct to Assistant Registrar (Appointments), National University of Lesotho, Roma, Lesotho by 11 April, 1980. Applicants resident in the UK should also send one copy to Inter-University Council, 90-91 Tottenham Court Road, London W1P 0DT. Further details may be obtained from either address.

TECHNICIAN

required in Department of Endocrinology to assist in a Medical Research Council funded project on the control of renin and aldosterone in normal subjects and patients with hypertension. Experience in radioimmunoassay would be an advantage. An HNC or equivalent qualification is essential. Incremental salary in the range £4125-£5817 per annum plus £398 London Weighting. Applications, giving details of age, experience and qualifications, together with the names and addresses of two referees, to The Secretary, The Medical College of St Bartholomew's Hospital, West Smithfield, London EC1A 7BE quoting reference 882.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Optical Systems and Devices Group

POSTDOCTORAL RESEARCH ASSISTANT CHEMIST OR PHYSICIST OR MATERIALS SCIENTIST

This group, engaged on various aspects of Optical Electronics, is seeking a Postdoctoral Research Assistant. His or her work will be concerned with the science and technology of a novel and potentially important fibre-optic directional coupler. Significant aspects of the project include the selection and preparation of both amorphous and electro-optic materials, the design and fabrication of test devices and the development of diagnostic methods at all stages of the process. Experience in one of the relevant areas involved would be desirable, ie crystal growth: optical device fabrication: the physics and chemistry of electro-optic materials.

The post is for three years starting as soon as possible. The salary is in the 1A range £5792-£9509 including London Allowance and USS. Starting salary depending upon age and experience.

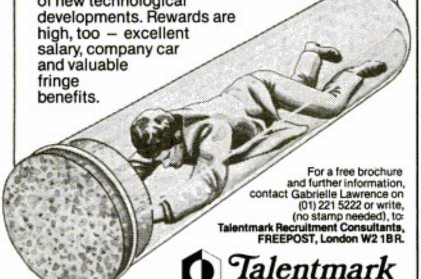
Applications, naming two referees, should be sent to Dr Mino Green, Electrical Engineering Department, Imperial College of Science and Technology, Exhibition Road, SW7 2BT.

A company whose business is the provision of **analytical and research services** wishes to expand by the **acquisition of similar companies.** Extensive instrumentation is available for the production of analytical data rapidly and economically.

Of particular interest would be companies engaged in substantial routine contract work where such instrumentation could be used to improve profit margins. Box number D464.

TRAPPED IN A JOB WITH NO FUTURE?

Looking for a more exciting way of capitalising on your scientific training? Like travelling and meeting people? Then you could have a challenging and highly rewarding career as a Technical or Scientific Representative.
It's a responsible and worthwhile job – visiting professional people in laboratories and hospitals, discussing the latest scientific advances, and encouraging the use of new technological developments. Rewards are high, too – excellent salary, company car and valuable fringe benefits.



For a free brochure
and further information,
contact Gabrielle Lawrence on
(01) 221 5222 or write,
(no stamp needed), to:
Talentmark Recruitment Consultants,
FREEPOST, London W2 1BR.

Talentmark
Leaders in Health Care Recruitment

UNIVERSITY OF SINGAPORE

DEPARTMENT OF PATHOLOGY

Applications are invited for appointments, ranging from Lectureships to Associate Professorships, in the Department of Pathology. Candidates must have a registrable medical qualification and relevant higher professional qualifications.

Annual emoluments range as follows:

Lectureship:	S$20 900–41 590
Senior Lectureship:	S$35 940–62 220
Associate Professorship:	S$54 080–72 240

The point of entry is dependent upon the candidate's qualifications, experience and the level of appointment. These emoluments include a 13th month allowance of one month's salary in December of each year and allowances recommended by the National Wages Council for 1978 and 1979.

For staff appointed on normal contract, emplacement on the permanent establishment will be considered after two 3-year contracts. Leave and medical benefits are provided. Under the University's Academic Staff Provident Scheme, the staff member contributes at the present rate of 16½% of his salary subject to a maximum of S$495/– pm, and the University contributes 20½% of his monthly salary. (The sum standing to the staff member's credit in the Fund may be withdrawn when he leaves Singapore/Malaysia permanently.) Other benefits include: a settling-in allowance of S$1000–2000 depending on circumstances, subsidised housing at rentals ranging from S$100–350 pm, passage assistance and baggage allowance for transportation of personal effects to Singapore.

Candidates should write to: **The Registrar, University of Singapore, Kent Ridge, Singapore 0511, giving their curriculum vitae and also the names and addresses of three referees.**

Closing date: 30 April 1980.

Health Physics Engineer

Oldbury-on-Severn Nuclear Power Station

£5200-£7630

The Health Physics Department at Oldbury-on-Severn Nuclear Power Station is involved with developing and reviewing the services and appropriate checks to ensure that the radiological safety of site personnel is maintained.
The successful applicant will assist in the operation of the radiological protection services to the power station, including personnel monitoring, radiological surveys, technical investigations and general advice on all Health Physics precautions.
He/she will assist in the training of industrial and other staff and will be involved with the planning of work for the Department. Additionally, the work involves aspects of the application of the "Asbestos Regulations".
Applicants should possess an engineering or physics qualification and experience of some of the above aspects of the work is desirable.
The salary offered is in the range £5200—£7630, which is to be reviewed w.e.f. 1/2/80. Terms and conditions will be those normal to a large organisation and include generous holidays, sickness benefits and contributory Superannuation scheme. Oldbury Power Station is situated approximately 14 miles north of Bristol and is close to the M4/M5 Motorway Interchange. Assistance will be given with relocation if appropriate.

To apply, telephone Bristol 648236 during office hours for an application form, or write to the Personnel Manager at the address below. Forms should be completed and returned quoting reference R66/79/NS by 8 April 1980.

Central Electricity
Generating Board
South Western Region
Bedminster Down, Bridgwater Rd.,
Bristol BS13 8AN

Technician

£3822-£4230 **Ewell**

For the Applied Physiology Section of the Department of Biological Sciences at North East Surrey College of Technology, Reigate Road. To prepare degree equivalent practicals and project work and be generally responsible for the Advanced Pharmacology Laboratory.
You should have had at least 2 years working experience in Pharmacology and possess an HNC or equivalent qualification.

Application form from the Personnel Section at the College. Tel: 01 394 1731 (Ref: CAO/BS/11).

SURREY
COUNTY COUNCIL

Administrative Assistant

Roche Products Limited is part of a major international pharmaceutical company based in Switzerland and is itself one of the leaders in the industry in the United Kingdom.

We currently have a vacancy for an Administrative Assistant in our Pharmaceutical Research Programme Administration Department part of a multidisciplinary Research Function located in modern buildings in Welwyn Garden City. The work involves the monitoring of development programmes, the organisation of documentation and the preparation of reports covering specific compounds in development.

Applications are invited from those with a degree in a biological science and preferably 2 years' post-graduate experience with a pharmaceutical company or related organisation. The post would be particularly suitable for a person now working in a research laboratory and who is looking for the opportunity of contributing to the administration of the Company's full range of development activities.

The Company offers excellent Conditions of Service which include a Christmas award, 23 days annual holiday, free life assurance and BUPA membership, subsidised restaurant and contributory pension scheme.

For further details and an application form please write briefly or telephone Mrs. M. Clewley, Welwyn Garden 28128, Research Personnel Department, quoting reference R10.

Roche Products Limited, P.O. Box 8,
Welwyn Garden City, Herts AL7 3AY.

ROCHE

Materials Scientist

Can you make an impact on tomorrow's technology?

Our business is energy storage, and 'packaged power', as we like to call it, is going to play an increasingly important role in tomorrow's world. That's why Chloride Technical – the Chloride Group's research and development centre – is continually seeking ways to improve our existing products, and developing new ones to meet the demands of the future. Key to all our development programmes is our team of Materials Scientists – the people who really understand the punishing environments the materials we use are exposed to. If you are an individual with drive and enthusiasm and have the ability to find novel solutions to materials problems – then we would like to hear from you.

You should have a good honours degree in Materials Science or a related discipline, with at least two years' research experience in industry or university. We can promise you an interesting career in an international company – with plenty of exposure to the real world of industry and its problems. Salaries (to be reviewed in April) are good – you will start between £5,830 and £6,400, according to experience, on a scale rising to £7,260, and there are excellent promotion aspects if you can demonstrate ability. Other benefits include a good pension scheme, and realistic relocation expenses. You will also find our location attractive – close to the M6, M62 and M56 motorways, making rural Lancashire, Yorkshire and Cheshire easily accessible by car.

Please write, quoting ref. 057/15 or telephone for an application form to:
Mrs. C. Hunter, Chloride Technical Limited,
Wynne Avenue, Swinton, Manchester
M27 2HB. Tel: 061-793 5000.

CHLORIDE

PLYMOUTH POLYTECHNIC

FACULTY OF MARITIME STUDIES

RESEARCH ASSISTANT in ASTRONOMY

Applications are invited from persons holding a good honours degree in Physics, Mathematics or Astronomy to conduct research into optical and radio-astronomical data connected with the magnetic field of the Milky Way using the Polytechnic's Prime computer installation. An interest in computing and astronomical data analysis is essential.

Research Assistants are normally required to register for a higher degree, although post doctoral applicants will be considered. The appointment will be for a period of two years with the possibility of a third year (fixed term contract). **Salary will be £3768 for post-graduates or £4068 post doctoral or equivalent, with annual increments of £150.**

Application forms to be returned by **Friday 28 March 1980**, can be obtained with further particulars from the **Personnel Officer, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA.**

Southampton THE UNIVERSITY

Department of Mechanical Engineering

Applications are invited for two lectureships in the Department of Mechanical Engineering for graduates with enthusiasm for and experience in teaching and research in:

Post 1 **Plasticity & Fracture Mechanics OR Applied Mechanics and Dynamics**

Post 2 **Engineering/Industrial Metallurgy**

Candidates for Post 1 should be professionally qualified graduate Mechanical Engineers with recent industrial experience.

Candidates for Post 2 should be professionally qualified graduates in Physical or Industrial Metallurgy with recent industrial experience.

The appointments will be made in the lower part of the salary scale £5052–£10 484 depending on age and experience.

Further particulars may be obtained from D. A. S. Copland, The University, Southampton SO9 5NH. Please state in which post you are interested. Applications (7 copies from United Kingdom applicants) should be sent not later than 14 April 1980, to the above address, quoting reference 249/A/NS.

JUNIOR LABORATORY SCIENTIFIC OFFICER required in Biochemistry and Chemistry Department. Applicants should have two Science "A" levels or equivalent qualification. Salary on scale £2595 at age 17, rising to £3618, plus £398 London Weighting.

Apply in writing, stating age and giving details of qualifications and experience (if any), to the **Secretary, Guy's Hospital Medical School, London Bridge SE1 9RT, quoting ref: BCl.**

DEPARTMENT OF INHALATION TOXICOLOGY

Technician or Graduate

to assist with chemical analysis

An assistant, technician or graduate, male or female, is required in the Department of Inhalation Toxicology to carry out quantitative analysis of aerosol samples.

The job involves analysis of a wide range of chemical substances and involvement in the associated method development. Ability to work with minimal supervision is desirable although an experienced chemist will be on hand when required.

Experience with HPLC, GLC and UV/vis. spectrophotometry is essential.

Salary for this new position would be dependant upon qualifications and experience. Minimum qualifications required are ONC, Medical Laboratory Sciences or equivalent.

Huntingdon Research Centre is a contract research organisation, the largest of its kind in the UK, working on the safety evaluation of pharmaceuticals, agrochemicals and industrial chemicals.

For an application form please telephone or write to the Recruitment Officer,
Huntingdon Research Centre,
Huntingdon, Cambs.
PE18 6ES.
Telephone Huntingdon (0480) 890431.

HRC

Huntingdon Research Centre

Director of Computing

Syria

An international agricultural institute seeks a computing professional, to set up and direct a timesharing system to support the Institute's teaching and research programme. The Director will participate in the selection of appropriate hardware and systems, and recruiting and training staff. Generous benefits will be available.

Please write, detailing your knowledge and experience in the following areas: retrieval systems; programming; supervision and staff training; any statistical or agricultural applications and foreign language ability.

Closing date: 13 April, 1980.

I.C.A.R.D.A. c/o 15 Sheepfold Lane, Amersham, Bucks.

METALLURGIST

(Higher Scientific Officer)

£5097 – £6737

Closing date: 23 April 1980

Job Ref. SB 101/80/S Tel ext 256

NORTHERN IRELAND OFFICE
NORTHERN IRELAND FORENSIC SCIENCE LABORATORY, Newtownbreda Road, Belfast

Applicants must possess:

1. a 1st or 2nd class Honours degree in Metallurgy; or
2. corporate membership of the Institution of Metallurgists; or
3. qualifications regarded by the Civil Service Commissioners to be of an equivalent or higher standard.

Candidates must also have at least 2 years' postgraduate experience in research or industry. It is essential that any candidate offering post-graduate qualifications in research must have a broad basic knowledge of metallurgy.

Applicants must be under 30 years of age at 31 December, 1980; exceptionally, applications may be considered from candidates over the age limit who have specialised experience.

The successful candidate will join a team of scientists engaged in the scientific investigation of crime throughout Northern Ireland. The work is interesting and varied and offers scope for developing interests in the various aspects of forensic science.

Starting salary will be related to qualifications and experience.

The pension scheme is non-contributory apart from a 1½% deduction from salary to cover widows benefit in the case of male officers.

There are promotion prospects to Senior Scientific Officer (£6332–£8705) and Principal Scientific Officer (£8613–£11 343).

The Commissioners may decide to interview only those applicants who appear from the information available, (including level of academic attainment and relevant experience), to be best qualified.

Expenses for travel (within the United Kingdom) incurred in attending for interview will be payable.

The post is open to both men and women. Please write or telephone for an application form (using the extension number indicated and quoting the job reference) to the Civil Service Commission, Rosepark House, Upper Newtownards Road, Belfast BT4 3NR (telephone Dundonald 4585). Completed forms must be returned to arrive not later than the closing date stated.

Department of Pathology

St. Stephen's Hospital,

Fulham Road, Chelsea, London SW10 9TH

REGIONAL CYTOLOGY CENTRE

Technician/ Junior Technician

to work in a large modern cytoloty department. The work will involve cytodiagnosis in all branches of cytology.

Applications invited from Science Graduates or personnel studying for ONC/HNC in Medical Laboratory Sciences.

Applications to Mr K. Prentis, Principal Technician, at the above address. Tel. No. 01 352-8161, ext. 336.

Research Division

We have opportunities for scientists/engineers and technologists to join research teams at our Technological Centre where we carry out R&D on all aspects of the Extraction, Fabrication and Applications of Alumina and Alumina Products.

ALUMINA APPLICATIONS

1. R&D Section Leader

The Chemicals Division of The British Aluminium Co Ltd is one of the major manufacturers in Europe of alumina based chemicals. A substantial proportion of this business involves the use of alumina in the ceramic, electro-ceramic and refractory industries.

An experienced scientist is required to form a small team within our Research Division to expand our existing product range and develop new uses for alumina in different industries. This is a key position and will involve some joint work with customers.

Applicants should have a good degree, preferably in physical chemistry, ceramics or material science together with a minimum of 5 years' relevant experience of new product or application development work. Experience in one or more of the following fields would be advantageous: ceramics, refractories, abrasives and catalysts.

2. Carbon Scientist

BSc (Materials Science) with 2-3 years' experience of PhD preferred. To join small team engaged in studies of structure, properties and the development of carbon electrodes used in aluminium smelting.

Applicants should have some experience in one or more of the following areas: materials examination, physical testing and particle characterisation.

3. Mathematician

(BSc Mathematics) to construct mathematical models to define the physics and/or chemistry of the process. The overall objective is to update process performance by innovative change based on sound process understanding. Some scientific data processing of experimental results together with statistical analysis of plant data will be necessary. Computer GEC 4070 with VDU terminals.

4. Microprocessor (Software)

To join our small team who are developing process control applications together with a team of electronic and control engineering experts. This is an exciting new field with excellent prospects. Applicants should have a scientific/technical background with some computing experience and a potential aptitude for microprocessor software. Training will be given as necessary.

Our staff work in small teams and all applicants for the above jobs should be able to work without supervision. We work closely with our 15 manufacturing plants throughout the UK and our customers.

Chalfont Park is about half a mile from Gerrards Cross situated in pleasant rural surroundings. (Free transport is provided from Gerrards Cross railway station). We offer attractive staff conditions—a 37 hour week with an early finish on Friday four weeks holiday per annum, pension and sick pay schemes.

For an application form please write or telephone to:

BACO
The British Aluminium Company Ltd

Staff Department, The British Aluminium Co Ltd, Chalfont Technological Centre,
Chalfont Park, Gerrards Cross, Bucks.
Tel: Gerrards Cross 87373.

Anglian Water Authority

CHEMIST
Post ref. R4S07
Grade 6: £6003-£6426 per annum

Applications are invited for the post of Chemist in the Divisional Scientist's Department based at Norwich.
The successful applicant will work in the Divisional Laboratory under the general supervision of the Principal Scientist. The main function of the post will be to carry out water quality analysis, particularly those analyses requiring the use of more advanced analytical techniques, associated with the monitoring of river water and effluent quality.
The Chemist will be responsible to the Principal Scientist for the organisation and supervision of the work of the Laboratory staff, and will be required to prepare analytical reports and records associated with the work of the Laboratory.
Applicants should hold a Degree or equivalent in Chemistry and be competent analysts with experience in instrumental methods of water analysis including the use of atomic absorption, GLC and auto-analysers.
National Joint Council for Water Service Staffs Conditions of Service apply. Generous relocation expenses in approved cases.

Application forms (to be returned by Monday, 14 April, 1980) and further particulars are obtainable from the Divisional Manager at the address below.

NORFOLK AND SUFFOLK RIVER DIVISION,
Yare House, 62/64 Thorpe Road, Norwich NR1 1SA
Telephone: Norwich 615161 Ext. 259

GUY'S HOSPITAL

Department of Clinical Physics and Bioengineering

MEDICAL PHYSICS TECHNICIAN GRADE II

is required to join a team developing and providing clinical measurement techniques based mainly upon the use of electronics. This is a well equipped department which is housed in new laboratories and which is engaged in a wide variety of applications of physical science in clinical situations.

The appointee will be responsible to the Consultant Clinical Physicist through the Chief Medical Physics Technician Grade 1.

An ONC and at least three years experience in constructing electronic equipment are essential; and HNC and experience of working in a hospital environment would be an advantage.

Salary: £5945 per annum rising to £7316 per annum.

For further information contact Dr C. A. Greatorex (ext 2570). Application forms are available from the Personnel Department, Guy's Hospital, St Thomas' Street, SE1 9RT—Tel: 01-407 7600 ext 3471.

TECHNICIAN (GRADE 4)

required in Department of Zoology, University of Reading with knowledge and experience of physiological techniques to assist individual members of academic staff with research and preparation of material for practical classes. Additional duties include supervision and organisation of some services and laboratories including the final year undergraduate project laboratory. ONC or similar qualification required. Salary in scale £3707-£4266 per annum (under review). Apply with full details of qualifications and experience and names of two referees to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH quoting ref TS 14A.

UNIVERSITY OF LIVERPOOL

Department of Botany

(Environmental Rehabilitation Unit)

TECHNICIAN (GRADE 4)

This Unit provides an advisory service and applied research facilities for Local Authorities and Industry on a wide range of environmental/ecological problems. Applicants should have wide experience of laboratory techniques for soil analysis with practical experience of Atomic Absorption Spectrophotometry. Supervisory experience is also important, as the successful candidate will be expected to supervise other technical staff and ensure the smooth running of the laboratory.

Candidates must possess ONC and have a minimum of seven years appropriate experience and a clean driving licence.

Candidates with ONC but less experience may be considered for lower graded post. This post is tenable for one year in the first instance but is renewable.

Salary within range £3707-£4266 per annum (from 1 April £3948-£4545 per annum).

Application forms may be obtained from The Registrar, The University, PO Box 147, Liverpool L69 3BX. Quote ref: RV/946/NS.

UPPINGHAM SCHOOL

Required for September a graduate to teach Physics throughout the School to Open Scholarship level. Applications from graduates who are not free until September 1981 are welcome.

Curriculum vitae with names, addresses and telephone numbers of three referees should be sent to the Headmaster from whom further information may be obtained.

Uppingham School, Uppingham, Rutland LE15 9QE. Telephone: Uppingham (057-282) 2216.

Plant Physiologists

Shell Biosciences Laboratory

Shell Research Limited is seeking to strengthen and expand its programmes in Plant Physiology as part of its overall research in new herbicides and plant growth regulants for use in world agriculture. The positions offered are important and challenging and we would like to hear from you if you are aged between 24 and 30 and have an appropriate Ph.D.

We have two vacancies for Scientists to initiate and pursue fundamental research related to the control of plant growth, with emphasis on enzymology. One of the appointments is particularly concerned with photosynthesis. Candidates should have some relevant experience and a working knowledge of organic chemistry.

Additionally we have two vacancies for Scientists with an interest in growth physiology of temperate and tropical crops. The successful applicant will be expected to develop physiological research as part of a multi-disciplinary team engaged on studies directed at finding new herbicides and plant growth regulators and improving crop productivity. Practical experience of controlled environment experimentation and an interest in subsequent field evaluation is essential as well as an ability to present good written reports. The possibility also exists for some overseas travel.

We offer a competitive salary and assistance will be given with relocation expenses where appropriate. You will be able to join our pension fund, enjoy flexible working hours and work in well-equipped laboratories which are situated on a 450 acre farmland site. There are also excellent facilities for sports and social activities. Please write giving all the relevant details about yourself and your career, or telephone for an application form to:

Mrs. M. Morley, Personnel Division, (N2), Shell Research Limited, Sittingbourne Research Centre, Sittingbourne, Kent ME9 8AG. Telephone: 24444. Ext. 602.

Shell

THE UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Surgery,
Royal Victoria Infirmary

Applications are invited from men and women for the post of:

LABORATORY TECHNICIAN

The successful candidate will be required to work in the Biochemical Laboratories of the Department and should have HNC or equivalent qualification in an appropriate subject and at least eight years' experience including training period. Candidates should have experience in Clinical Biochemistry and a working knowledge of automated equipment would be an advantage. Grade 5 salary scale £3996-£4668 per annum.

Written applications giving details of age, qualifications, experience, present salary and the names and addresses of two referees to Professor I. D. A. Johnston, Department of Surgery, Royal Victoria Infirmary, Newcastle upon Tyne NE1 4LP.

INFORMATION SCIENTISTS

London-based management consultants seek freelance information scientists with on-line experience, ideally with patent and techno-commercial databases. Details to Box D469, New Scientist.

The Queen's University of Belfast

Post-Doctoral Scientist

Departments of Biochemistry and Medicine

This post tenable for one year from 1 April, 1980 would be of interest to graduates in biochemistry or organic chemistry. The work involves the purification and characterisation of glucagon—like peptides in the gut. Experience in protein chemistry and enzymology would be an advantage.

Salary in the range £5052–£5727 per annum, placing depending on age and experience.

Curriculum vitae and the names and addresses of two referees should be sent to the **Personnel Officer, The Queen's University of Belfast BT7 1NN, Northern Ireland. Closing date: 28 March, 1980.**

TECHNICIAN/ RESEARCH OFFICER

required to assist research scientists in the operation of cell-sorting experiments involving fluorescent cell sorters. Duties include operator services and all aspects of maintenance.

HNC/Degree with general laboratory experience. An interest in computers would be an advantage. Salary range £4500 to £6500. For further information and application form write to or telephone **Miss S. M. Hurley, Imperial Cancer Research Fund, Lincoln's Inn Fields, London WC2 on 242 0200 ext. 305.** Quoting reference 163/80.

NATIONAL HOSPITALS & INSTITUTE OF NEUROLOGY

SENIOR TECHNICIAN/ TECHNICIAN

required in routine Chemical Pathology Department. Applicants should be suitably FIMLS/AIMLS. Enquiries to Miss Chambers, tel: 01-837 3611, ext 513. Canteen, interest-free travel loan. Written applications with cv and names of three referees to Secretary, Institute of Neurology, National Hospital, Queen Square, London WC1.

THE OPEN UNIVERSITY

FACULTY OF TECHNOLOGY

Course Co-ordinator

Applications are invited for the above post. The appointee will assist in the maintenance and/or production of courses in electronics and telecommunications.

The post would suit a recent graduate in science, engineering or mathematics, although non-graduate applicants having recent relevant experience will also be considered.

Salary will be at an appropriate point on the scale £4402–£7410 per annum.

Application forms and further particulars are available from:

Mrs A. Torr, Faculty of Technology (AT3095/1), The Open University, Walton Hall, Milton Keynes MK7 6AL, or telephone Milton Keynes 653880: there is a 24 hour answering service on Milton Keynes 653868.

Closing date for applications: 31 March.

Physicists/ Engineers

Nuclear Associates is a consulting service of Control Data Limited, part of one of the world's most respected multi-national computer manufacturing and services organisations.

We currently require a limited number of experienced Physicists/Mathematicians/Engineers for computer projects and marketing support work in the nuclear power industry. These challenging and rewarding positions could be based at Control Data locations in London, Birmingham or Haydock (near St. Helens).

Applicants should be graduates (or equivalent) with a minimum of 3 years' relevant industrial experience which must include one or more of the following specialisations: reactor safety analysis; core physics/fuel management studies; shielding; criticality. PWR experience would be an added advantage.

Well qualified candidates will be offered highly competitive salaries, together with a comprehensive range of large-company benefits (including generous assistance with relocation where appropriate). Prospects of career advancement are excellent.

For further information, please contact
Dr. Steve Flanagan on 0942 74111,
or write to him for an application form at
Nuclear Associates, New Haydock Industrial Estate,
Bahama Road, Haydock, Lancs.

NUCLEAR ASSOCIATES
A consulting service of
CONTROL DATA

THE UNIVERSITY OF HULL

A vacancy exists in the Zoology Department for an

ELECTRONICS TECHNICIAN

Grade 5. The post, which is tenable for three years and funded by the Wellcome Trust, will involve the design and construction of electrophysiological apparatus associated with Professor Donaldson's Neurophysiological Research Unit, and some servicing and testing of equipment. A knowledge of digital electronics is essential. Qualifications: ONC, or equivalent, and seven to nine years relevant experience. Salary on the scale £3996-£4668 per annum (under review).

Applications, giving details of age, qualifications and experience should reach the Technical Staff Officer, University of Hull, HU6 7RX by 26 March, quoting the names of two referees and ref no: TZ/1.

GRADFIT APPOINTMENTS REGISTER

We specialise in jobs for graduates, with small/medium sized firms.

We require Electronic, Elec/Mech. Engineers, Metallurgists, Physicists, Chemists preferably with some experience.

Free service to you—Register today GRADFIT, 3 Speen Lodge Court, Newbury, Berks. Tel: 0635-49122.

Churchill Hospital Research Institute
University of Oxford

Applications are invited for the post of

BIOLOGIST/ PHYSIOLOGIST

to join a team comparing the effects of irradiation with X-rays and fast neutrons on normal tissues. The post is suitable for a post doctoral research worker and the successful candidate will mainly be responsible for investigating both functional and morphological changes in the kidney in order to gain a better understanding of the pathogenesis of late radiation damage in this organ.

Further details and applications (with the names of two referees) to Dr J. W. Hopewell, Churchill Hospital Research Institute, Headington, Oxford. By 24 March, 1980.

UNIVERSITY OF LONDON

Institute of Neurology

LABORATORY TECHNICIAN

required for Neurotoxicity Project to undertake EM work in association with graduate scientist. Some experience in EM methods and photography an advantage. Salary on scale £4374-£4872, including London weighting. Canteen, interest free travel loan. Applications with cv to Prof J. B. Cavanagh, Institute of Neurology, National Hospital, Queen Square, London WC1N 3BG.

UNIVERSITY of EDINBURGH
Department of Chemistry
and
ICI Ltd, Organics Division

Postdoctoral Research in Organic Chemistry

Applications are invited for a Postdoctoral Research Fellow to take part in a joint research programme to investigate the chemistry of nitrile sulphides and synthesise novel biologically-active sulphur-nitrogen heterocycles. The work will be carried out in collaboration with Dr R. M. Paton, from whom further details may be obtained. The post is tenable for three years and is funded by an ICI Joint Research Scheme. Starting salary will be within the range £5052–£6062 depending upon age and experience and is subject to annual increments and USS.

Previous experience in mechanistic and/or heterocyclic chemistry would be advantageous but is not essential.

Applications, giving a curriculum vitae and the names of two referees, should be sent as soon as possible to **Dr R. M. Paton, Department of Chemistry, University of Edinburgh, West Mains Road, Edinburgh EH9 3JJ.** Please quote Reference 5012.

ASPINWALL GROUP

HYDROGEOLOGISTS, ENGINEER/HYDROLOGIST

We are a specialist group providing professional advice and expertise in the fields of water resource evaluation and management; landfill investigation, design and monitoring for public authorities, private industry and agriculture both in the UK and overseas.

Our expanding work load now requires us to appoint additional professional staff.

Applicants for the hydrogeological posts are invited from both extensively experienced and less experienced personnel. It is essential that applicants for the Engineer/Hydrologist posts are MICE.

Salary is negotiable. A car will be provided.

Applicants should send full cv in confidence to: **Aspinwall Group, Pengwern Court, High Street, Shrewsbury SY1 1SR.**

ROYAL FREE HOSPITAL

MOULD ROOM TECHNICIAN

To join an exciting department which has the first computerised cobalt tracking unit in the world.

The duties involve mould room work and liaising with the Radiotherapy planning and treatment teams. There will be responsibilities also in the use of sealed Radioactive sources.

Applicants (M/F) should be suitably qualified (minimum ONC) and experience in this field is necessary and further training will be given.

Salary on scale MPT IV £4280 per annum to £5504 per annum, inclusive.

Application form and job description from Personnel Department, Pond Street, London NW3. Tel: 01-794 0500 ext 4286. For further information contact Miss L. Chidirchi ext 3161.

THE CITY UNIVERSITY

Civil Engineering Department

TECHNICIANS GRADE 4— ENVIRONMENTAL LABORATORY

Duties will include making up various pieces of apparatus under supervision, and assisting in tests and experimental procedure.

Experience of laboratory work and a practical approach are essential, a working knowledge and understanding of electrical layouts for lighting, heating and sound (acoustic) work, would be a distinct advantage. Minimum age 21, and apprenticeship related to Instrument or Scientific work is desirable.

Salary will be in the range £4728-£5325 inclusive.

GRADE 5— HYDRAULICS SECTION

Duties will include setting up undergraduate teaching experiments, the manufacture, setting up and development of final year undergraduate projects and the maintenance of all hydraulic equipment appertaining to Civil Engineering.

Applicants should have appropriate experience and must be capable of working on their own initiative.

Salary will be in the range £5037-£5754 inclusive.

To apply please contact Ms Jane Cameron, Personnel Recruitment Assistant, The Personnel Office, The City University, Northampton Square, London EC1V 0HE. Tel: 250 1107 (ansaphone).

THE UNIVERSITY OF MANCHESTER

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMISTRY

Applications are invited for a postdoctoral post to work under the supervision of Professor R. Grice on reactive scattering experiments using supersonic beams of atoms and free radicals. Experience in the fields of mass spectroscopy or reaction kinetics would be an advantage but not essential. The appointment will be for two years with a starting salary of up to £5725 per annum, depending on age and experience. Applications including curriculum vitae and the names and addresses of two referees should be sent to the Registrar, The University, Manchester M13 9PL, to be received by him not later than 18 April, 1980. Quote ref: 50/80/NS.

TECHNICIAN (GRADE 3 OR GRADE 4)

required in Department of Physiology & Biochemistry, University of Reading, to assist with research and teaching. Experience of biochemistry and/or animal physiology essential and experience of use and care of high speed centrifuges is required for appointment at Grade 4. Salary in scale £3372-£3840 per annum (Grade 3) or £3707-£4266 per annum (Grade 4) (under review). Apply with full details of qualifications and experience and names of two referees to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH quoting ref TS 15A.

ELECTRON MICROSCOPE/ MICROPROBE TECHNICIAN (GRADE 5)

required in Department of Geology, University of Reading to operate and maintain a variety of electron beam equipment. Previous experience essential. Salary in scale £3996-£4668 per annum (under review). Apply for further details to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH quoting ref TS10A.

Have you heard the one about the Russian, the American and the Belgian?

At the vast Telecommunications exhibition — Telecom '79 — in Geneva last year, our System X telephone exchange (in full working order) proved its Star Quality. The competition couldn't keep its hands off it. A Russian tried to photograph it; an American tried to sketch it; and a Belgian was all set to clip a 'souvenir' off it.

SYSTEM X — BRAINCHILD OF A TOTAL SYSTEMS STRATEGY

In purely technical terms System X is a family of new switching and associated systems using micro-electronic technology, integrated digital transmission and switching, stored program (software) control and common channel signalling.

In terms of foresight though, it is an enterprise of epic dimensions. By far the largest single telecommunications project ever undertaken in Britain, and already enjoying international acclaim, it is an evolutionary system, with a framework both flexible and versatile. Its modular construction will allow us, with little re-design, to meet any foreseeable demands from a public hungry for new and exciting, but vastly complex audio, visual and information services. It is this specification which makes System X, in world terms, unmatched by any other comparable system.

SYSTEM X — HOW IT COULD ADVANCE YOUR CAREER

Project management experience The areas of work available are extremely varied. For instance, you could be testing, monitoring or developing the design of a subsystem; evaluating system and subsystem performance; identifying problems for urgent solution; assessing current achievement or managing large software development facilities. In short, project management where a sound technical background is vital.

Experience in depth gained in an environment where the total corpus of telecommunications knowledge is readily accessible.

Project variety One of System X's virtues — and part of its sales appeal — is its capacity to dovetail into existing systems. Some interesting planned 'marriages' will result; and you could be in charge of such projects.

Excitement and why not. Enjoy the challenge and the satisfaction of contributing to a technological masterpiece that will bring tomorrow's world closer.

Personal development A high priority with us. We encourage the learning of management skills as well as technical expertise. With the growth of our telecommunications business, there are good opportunities for promotion.

Salaries Definitely attractive; and about to go up still more.

Qualifications A good Degree in an appropriate subject e.g. electronics, electrical engineering, physics, computer science, or Corporate Membership of IEE, IERE etc.

To talk to an Engineer about the posts available in **London** and **Ipswich**, ring Bill Jones, Head of Subsystem Development, on Freefone 3615. For an application form and general information, write to: Telecommunications Management Recruitment Centre, Ref. NS1, Freepost, London WC1E 6BR, or ring Freefone 2237 (obtainable through Operator).

Post Office
Telecommunications

LaserScientist

The Rutherford & Appleton Laboratories one of the Science Research Council's principal establishments for advanced work in physics is also one of Europe's leading centres for laser research.

The Laser Division has a vacancy for a Scientist to work in an existing programme of gas laser development. The present emphasis in this area is on the development of efficient, high power, rare-gas halide lasers for use within the Laser Division for laser-plasma interaction studies and for photochemistry applications. The successful candidate will participate in research projects already underway, and will be encouraged to contribute original ideas for future work in the gas laser programme.

A Ph.D. in physics or a related area is required, and previous experience with rare-gas halide lasers and in gas discharge physics would be an advantage.

The appointment will be at the Higher Scientific Officer level and salary will be within the range £5,097-£6,737. **(There is also a non-contributory pension scheme).**

Please telephone for an application form to Jane Williams in the Personnel Group on Abingdon (0235) 21900 Ext 510 or write to her quoting reference VN. 883 at Rutherford & Appleton Laboratories, Chilton, Didcot, OXON OX11 0QX

Closing date for applications: 28th March 1980.

SRC

Rutherford and Appleton Laboratories

UNIVERSITY OF EDINBURGH
Department of Cardiology
(Prof M. F. Oliver)
Supported by the
British Heart Foundation

BIOCHEMIST

required by a research team, working in the field of ischaemic heart disease. Current studies, in which biochemical aspects are central, are directed towards metabolic and pharmacological aspects of adrenergic mechanisms, in relation to electro-physiological abnormalities during an acute heart attack. An epidemiological study of metabolic disorders in relation to heart disease in Scottish men is in preparation.

The successful candidate will be responsible for the development of the biochemical techniques required, as indicated by the overall research activities. Current techniques: radiochemical enzymatic assay of catecholamines; fluorimetric enzymatic techniques; analysis of complex plasma and platelet lipids (GLC), etc. Opportunities to work towards a higher academic degree are available.

Candidates should have at least a BSc honours. Preference will be given to applicants with an interest in metabolism and practical experience in analytical procedures (not necessarily those listed above). The post will be initially for 3 years. Salary will be in the range £4402–£6399.

Informal enquiries and applications including curriculum vitae: **Dr R. A. Riemersma, Lipid Research Laboratory, The Royal Infirmary, Edinburgh EH3 9YW (Telephone: 031-229-2477 Extn. 2176). Please quote Reference 5077.**

WELSH NATIONAL SCHOOL OF MEDICINE
(University of Wales)

Department of Medical Biochemistry

RESEARCH OFFICER

required to work on a project funded by the MRC investigating the mechanism of action of insulin on human adipose tissue and cells grown in tissue culture.

The post is available for three years and the salary is on the scale £4153-£4766 (under review). Preference will be given to candidates interested in the opportunity of possible candidature for a higher degree.

Applications in writing with the names and addresses of two referees (quoting ref no C38/4/30) should be submitted to the Registrar and Secretary, Welsh National School of Medicine, Heath Park, Cardiff CF4 4XN (tel: 0222 755944 ext 2296) from whom further particulars can be obtained. Closing date for application 31 March, 1980.

ORGANISING SECRETARY

required for

ANIMAL WELFARE SOCIETY

It is envisaged that the person appointed will be 25-35 years with a good all-round education and experience in office administration.

Commitment to the animal welfare cause essential. Ability to type and drive an advantage and experience in public speaking will prove useful.

Salary by negotiation depending on experience.

Applications in writing to **The President, Scottish Anti-Vivisection Society, 121 West Regent Street, Glasgow G2 2SD.**

UNIVERSITY OF LIVERPOOL

Department of Electrical Engineering and Electronics

Applications are invited for the post of

LECTURER

in the Department of Electrical Engineering and Electronics. Preference will be given to candidates with an interest in research in the general field of electrical power, machines or control systems.

Initial salary within the range £5052-£6399 per annum.

Further particulars and application forms may be obtained from The Registrar, The University, PO Box 147, Liverpool L69 3BX, by whom completed forms should be received not later than 10 April, 1980. Quote ref: RV/947/NS.

FIELD STUDIES COUNCIL

Full-time gardener required at a Field Centre in South Devon. Previous experience an advantage. Possibility of research/teaching in spare time. Contact the Warden, Slapton Ley Field Centre, Slapton, Nr. Kingsbridge, Devon.

Scientists/Technicians

We have the following vacancies in London and the Home Counties for:
- Electronic Engineers/Project Leaders in Electro-Chemical fields
- Electrochemists
- Chemical Engineers

and for people with experience as:
- Paint Chemists
- Plastics Technologists
- Polymers Technologists
- Cosmetics Chemists
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KITCHENS OF SARA LEE UK
Manufacturer of Frozen Foods

Due to expansion of our manufacturing operation, we require **shift quality controllers** to be responsible for the efficient running of the QC programme Applicants should be qualified to at least ONC standard in science or food technology. Some experience in the food/beverage industry is desirable but not essential. A competitive salary, contributory pension scheme and other benefits are available.

Please write and give full details of qualifications and experience to:

Quality Control Manager, Kitchens of Sara Lee UK, Lancaster Road, Carnaby Ind Est, Bridlington, North Humberside YO15 3QY.

THE POLYTECHNIC OF CENTRAL LONDON
Science Division

RESEARCH ASSOCIATE

A post is available for two years to assist on a NRDC funded project concerned with the production, isolation and characterisation of antibiotics from fermentations of clinically isolated dermatophyte fungi. Candidates should possess an AIMLS qualification or BSc (which includes microbiology). Preference will be given to applicants with experience of hospital microbiology. The work will be undertaken both at the Polytechnic and also at St John's Hospital for Diseases of the Skin, Homerton. **Salary scale:—** £4377—£4527 Including London Allowance.

Application form and further details from the **Establishment Officer, PCL, 309 Regent Street, London W1R 8AL (Tel. 01-580 2020 ext. 212).**

TECHNICIAN (GRADE 3)

required in Plant Science Laboratories, University of Reading for Ecology Teaching and Research section. Varied duties including assistance with crop experiments in the field, plant growth analysis, running computer programmes and producing diagrams for publications. Driving licence an advantage. Minimum qualifications ONC or SLT Pt 1 or 2 Science "A" levels, plus laboratory experience. Salary in scale £3372-£3840 per annum (under review). Apply with names of two referees to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH quoting ref TS 13A.

Starch/Sweeteners Business Development Opportunity in Canada

Ogilvie Mills, a leading Canadian food and agri-products company, has an outstanding opportunity for a self-motivated and entrepreneurial professional to participate in providing future strategic direction for the company.

The Business Manager – Carbohydrates will be responsible to the Vice-President – Planning and Development for the identification of opportunity in carbohydrates and carbohydrate-derived products and providing market-oriented support in formulating business strategies to assist corporate activities in commercialising these opportunities.

A chemical or chemical engineering background, broad experience in starch and/or starch-related products and a sound practical understanding of the commercial factors involved in such industries will be needed to successfully meet the challenges this position will provide.

The salary will reflect the importance of the position and the compensation package includes a management bonus plan, pension scheme, life and disability insurance and comprehensive medical and dental plans.

Ogilvie Mills comprises the agri-products group of John Labatt Ltd., a major Canadian-owned public corporation operating from coast to coast with over 12,000 employees and sales around 1.5 billion dollars. The company is a major participant in brewing, wines, consumer foods and food ingredients. It is involved in the starch and starch sweetener industries and is actively seeking to expand its current base in this business.

We plan to conduct interviews in the U.K. during the first week of April. Airmail full details about yourself, qualifications, experience, salary progression and contact telephone number to arrive before March 28th to: **Mr. Graham Strachan, Vice President, Ogilvie Mills Ltd., 1 Place Ville Marie, Montreal, Quebec, Canada, H3B 2X2.**

UNIVERSITY OF BATH

School of Materials Science

POLYMER ENGINEERING RESEARCH

This new investigation into the fracture of grp offers experience in: Commissioning a purpose-built servo-hydraulic test rig, Developing software for high speed data acquisition, Using electron optical and acoustic emission techniques.

It will provide a challenge for an engineer, materials scientist, metallurgist or physicist who is either post doctoral or has relevant industrial experience.

The work is directed by Mr M. G. Phillips, funded by the Polymer Engineering Directorate of SRC for a period of three years.

Commencing salary up to £5725 per annum.

Application forms from the Personnel Officer, University of Bath, Bath BA2 7AY, quoting reference number 80/30R. Closing date will be 27 March, 1980.

ELECTRONICS TECHNICIAN (GRADE 5)

required in the Department of Psychology, University of Reading to take charge of electronics workshop, advise staff and students on electronics problems, and design and construct wide range of specialised equipment. The research programme already depends heavily on advanced digital and analogue techniques. Recognised qualification or apprenticeship and at least seven years of varied experience in electronics are essential. Salary in scale £3996-£4668 per annum (under review). Apply with names of two referees to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH quoting ref TS 11A.

The Department of Paediatrics at the Cardiothoracic Institute has a vacancy for a

JUNIOR A MEDICAL LABORATORY SCIENTIFIC OFFICER

in its **Paediatric Cardiac Morphology section.** The work mainly consists of histology and photography: in service training will be given in addition to day release for relevant studies. This post presents an ideal opportunity for a keen school leaver wishing to embark on a career in medical technology.

Applicants should have a minimum of 4 "O" levels including English, Maths and two science subjects (minimum grade "C"). Apply to the Secretary, Cardiothoracic Institute, Fulham Road London SW3 6HP, stating age, qualifications and the names of two referees. Quote Ref. PCM 1/80.

ROYAL FREE HOSPITAL SCHOOL OF MEDICINE

University of London

TECHNICIAN

Technician required to work with Professor J. A. Lucy in the Department of Biochemistry on a research project concerned with studies on the fusion of biological membranes, supported by a grant from the Medical Research Council. Salary on Whitley Council scale according to age and experience. Appointment until 31 July, 1982, to start as soon as possible. Further details and application forms from the School Secretary, RFHSM, 8 Hunter Street, London WC1N 1BP. Tel: 01-837 5385, ext 54. Closing date: 28 March, 1980.

UNIVERSITY OF LIVERPOOL

Department of Geography

Applications are invited for the post of

RESEARCH ASSISTANT

to assist Dr A. Henderson-Sellers in an NERC funded theoretical investigation of the methods of parameterising albedo using satellite data. Candidates should have a good science/engineering degree and be willing to acquire the necessary computing skills. However in the important new field of remote sensing of the environment the primary qualifications are enthusiasm and an interest in the interpretation of the rapidly expanding data set.

The post is tenable for one year at a salary of £4402 per annum.

Applications, together with the names of three referees, should be received not later than 28 March, 1980 by the Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote ref: RV/950/NS.

ELECTRONICS TECHNICIAN (GRADE 5)

required in Departments of Physiology & Biochemistry and Zoology, University of Reading to run a small electronics workshop with one other staff. Duties include maintenance of existing and construction of novel electronic apparatus; familiarity with fault-tracing techniques and ability to construct equipment from circuit diagrams essential. Salary in scale £3996-£4668 per annum (under review). Apply with full details of qualifications and experience and names of two referees to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH quoting ref TS 16A.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

Winches Farm Field Station
395 Hatfield Road, St Albans
Herts AL4 0XQ

RESEARCH TECHNICIAN

to join a team working on the experimental immunology of schistosomiasis at the School's Field Station in St Albans. Activities of the group include cellular immunology, immunochemistry, in vitro culture and parasite life-cycle maintenance, and experience in one or more of these areas would be an advantage. Appointment for 18 months in the first instance. Salary on the scale £4523-£5231, depending on qualifications and experience. Further information from, and applications (with full details of career and names of two referees) to: Dr M. J. Doenhoff, Department of Medical Helminthology. (Tel: St Albans 34201.)

THE LONDON HOSPITAL MEDICAL COLLEGE

(University of London)

Department of Medical Microbiology

RESEARCH ASSISTANT

required to study the activity of various new beta-lactam antibiotics. Applicants should hold an Honours BSc in Microbiology. The appointment will be for one year in the first instance but with possibilities for extension and registration for a higher degree. Salary £4153+£740 London Weighting (under review). Please apply giving details of education and experience to Dr R. Williams, Department of Medical Microbiology, The London Hospital Medical College, Turner Street, London E1 2AD.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

Chemists & Chemical Engineers

The United Kingdom Atomic Energy Authority Establishment at Winfrith, Dorset has vacancies for young, practical Chemists/Chemical Engineers to join teams either developing pilot plant for the treatment of low level and medium level radioactive waste, or measuring by the combination of radiochemical and physical techniques very small amounts of various radionuclides present in a variety of environmental and biological materials.

This is an opportunity to take part in established and expanding programmes and to be involved in modern developments in plant automation, processing and analyses. We are looking for candidates who can demonstrate a blend of scientific understanding with good experimental and practical ability. For some vacancies experience in a chemical laboratory, involving analytical techniques, preferably in the field of radiochemistry, is required. A familiarity with modern data-handling techniques would be an advantage.

Applicants should have a degree or Higher National Certificate/Higher Diploma, or equivalent qualification, in Chemistry or Chemical Engineering or other appropriate technological subjects.

Appointments will be at the Scientific Officer and Higher Scientific Officer levels in the range £3,845-£7,210 per annum, the starting salary depending upon age, qualifications and experience.

Winfrith is situated close to the Dorset coastline and within easy reach of Dorchester, Weymouth, Poole and Bournemouth. Housing or assistance with house purchase will be available to married officers living beyond daily travelling distance.

Please write for an application form to:-

Appointments Officer (A) Personnel Branch, AEE Winfrith, FREEPOST, Dorchester, Dorset DT2 8DH, (no postage stamp necessary).

Telephone Dorchester (0305) 3111 Extn. 3049. (Reference WA 322).

Winfrith

LONDON SCHOOL OF ECONOMICS

COMPUTERS IN GEOGRAPHY

Applications are invited from experienced programmers for a post in the Computer Service of Analyst/Programmer with special responsibility for the work of the Department of Geography. Duties will include the design and development of applications software, program conversion, provision of courses for use within the Department's teaching programme, and specialist advice to staff and students on data sources, graphical presentation of data, survey preparation and analysis, use of statistical packages and digital simulation.

Applicants should be graduates either in Geography with considerable experience of programming computers or in Statistics/Numerical Analysis/Computing with experience in relevant application areas.

Salary in the range £5142-£8150 (from 1 April) including London Allowance.

Application forms, returnable by 28 March, 1980, should be obtained from Assistant Personnel Officer, LSE, Houghton Street, London WC2A 2AE. Tel: 404 4769.

CHESTER COLLEGE OF HIGHER EDUCATION

LECTURER II/SENIOR LECTURER IN BIOLOGY

Applications are invited for the above post, tenable from 1 September next. The person appointed should have a good Honours degree in Biology and should be either a Microbiologist with an interest in public health or an Environmental Biologist with an interest in the social applications of biology. Experience of teaching or of work in the public services would be an advantage. Salary within the range £4806-£8871 depending on qualifications and experience.

Further details from the Principal, Chester College, Cheyney Road, Chester CH1 4BJ.

BUREAUTECH (SCIENTIFIC STAFF AGENCY)

Top jobs for ONC/HNC/HND/AIMLT BSc. (Chem; Phys; Biol; Med. Lab. subjects; Electronics and Metallurgy.)

Immediate vacancies for Paint, Ink and Surface Coating Technologists. We find you the job free of charge.

Tel: 01-906 0251.

MICROBIOLOGIST

A graduate microbiologist, preferably with some relevant experience, is required to join a team working on bacterial spore resistance to heat and chemicals. The successful candidate would be expected to give some assistance with other activities undertaken by the department. The salary would be from £3348-£5844.

Further details and application form from Mr R. H. Thorpe, Campden Food Preservation Research Association, Chipping Campden, Glos GL55 6LD. Telephone Evesham (0386) 840319.

RESEARCH TECHNICIAN

required for English-speaking molecular biology department. Position involves operation of computer-controlled cell separator in studies of cellular differentiation and genetic expression. Interest in cell biology essential. Experience in use of computers and facility with electronic equipment and general biochemistry and tissue culture techniques desirable. Salary from 25 000-30 000DM per annum, according to experience. Position starting latest June 1, 1980. Applications with CV and names of two professional references should be sent to Dr Donna Jovin, Max-Planck-Institut f Biophysikalische Chemie, Postfach 968, D-34 Goettingen, W. Germany.

UNIVERSITY OF DUBLIN
Trinity College

SENIOR LECTURER in MICROBIOLOGY

Applications are invited for the above position in the Department of Microbiology, Trinity College, Dublin. Candidates should have broad teaching experience of General Microbiology. Although no particular field of research is specified, candidates should note that the Department presently specialises in bacterial and viral pathogenicity, plasmid genetics and bacterial membranes and surfaces. The successful candidate will be expected to undertake substantial administrative duties within the Department.

Salary Scale: £9925–£12181 pa.

There is a non-contributory pension scheme.

Application forms and detailed further particulars relating to this post may be obtained from:—

**The Establishment Officer,
West Theatre,
Trinity College,
Dublin 2.
Tel. 772941, ext. 1775.**

The closing date for receipt of applications will be Friday, 11 April, 1980.

UNIVERSITY OF SOUTHAMPTON

School of Biochemical and Physiological Sciences

GRADUATE RESEARCH ASSISTANT

Applications are invited for appointment as a Graduate Research Assistant in the Nutrition Group of this School, to work with Dr D. York on the regulation of [Na++K+] ATP-ase in obese mice. The appointment, for 18 months, is funded by the British Diabetic Association. Applicants should have a good Honours Degree in Biochemistry, Nutrition, Pharmacology or related discipline and have an interest in Metabolic Disease States.

The salary will be within £4402 per annum-£5052 per annum on scale 1B for Research and Analogous Staff; USS benefits.

Applications giving date of birth, curriculum vitae and the names and addresses of two referees, should be sent to Mrs P. Vaughan-Smith, The University, Southampton SO9 5NH, by 1 April, 1980. Please quote ref: 1126/R/NS.

POISONS UNIT

**New Cross Hospital,
Avonley Road, London
SE14 5ER**

The National Poisons Information Service

requires an

INFORMATION OFFICER

prepared to work shifts to maintain a 24hr, 7 day a week service for the medical profession on the treatment of acute poisoning. We are looking for recent scientific graduates or persons with a similar background to work in a team of nine.

Basic salary for new entrants to the NHS is £3540 plus 20 per cent shift allowance plus London Weighting of £398 per annum.

For further information please contact Mrs B. Davison on 01-407 7600 ext 4007 or write to her at the above address.

WEST MIDLANDS COUNTY COUNCIL

TRADING STANDARDS DEPARTMENT

CHIEF ANALYST
£9717–£10 431

Post ref TS 310

The postholder is responsible for the Analytical Laboratory of the Trading Standards Department which carries out a wide range of analytical functions including those under Food and Drugs, Agriculture, Consumer Protection and Safety, Health and Safety at Work and Control of Pollution Acts. The Chief Analyst also acts as a consultant to the Trading Standards and other Departments of the County Council.

Applications for this post are invited from persons holding the qualifications of MChemA and the Diploma of Fellowship of the Royal Institute of Chemistry and with wide experience in the field of analytical services.

The West Midlands is a progressive County in this field and the successful applicant will be a member of the Departmental Management Team.

STARTING SALARY NEGOTIABLE WITHIN RANGE STATED. COMPARABILITY AWARD PENDING. RELOCATION EXPENSES AVAILABLE. ESSENTIAL CAR USER ALLOWANCE PAYABLE.

Further information available from Deputy County Trading Standards Officer, Mr R. V. Wright on telephone 021-300-6201.

All applications by letter only stating post ref no, age, education, qualifications, experience, present and previous appointments with salary details to: **County Personnel Officer, West Midlands County Council, County Hall, Birmingham B4 7DJ by 21 March, 1980.**

SOUTH EAST THAMES REGIONAL HEALTH AUTHORITY

in co-operation with the University of Surrey

BASIC GRADE BIOCHEMISTS

The Authority offers special training posts with the opportunity to study for an MSc in Clinical Biochemistry.

Posts are available from October 1980 for a two-year sandwich MSc course at the University. In the case of fresh graduates a good Honours degree, eg Biochemistry or Chemistry (or its equivalent) is essential. Salary would be at the appropriate point on the scale commencing £4464 per annum and rising by one annual increment to £4677. London Weighting Allowance of £398 per annum is payable when applicable.

During the parts of the course spent away from the University, students would work in a specified hospital laboratory in the area of the Authority. The Certificate of Proficiency will normally be issued to candidates successfully completing the two-year course.

University application form together with the Post-Graduate Prospectus, and separate Regional Health Authority application form and sponsorship details are obtainable from the Academic Registrar, University of Surrey, Guildford. Applicants must give past examination grades.

Closing date for receipt of applications: 11 April. (Ref: 030.)

TECHNICIAN (GRADE 3)

required in Departments of Physiology & Biochemistry and Zoology, University of Reading, to work under supervision in small well equipped mechanical engineering workshop, producing items in variety of materials such as metals, plastic and wood for teaching and research. Some practical experience of basic workshop techniques essential. Salary in scale £3372-£3840 per annum (under review). Apply with names of two referees quoting ref: TS03A, to Assistant Bursar (Personnel), Whiteknights, University of Reading, Reading RG6 2AH.

UNIVERSITY OF BRISTOL

Faculty of Engineering

LECTURER WITH SPECIAL RESPONSIBILITY FOR ORGANISING IN-CAREER COURSES FOR INDUSTRY

The Faculty of Engineering intends to appoint a lecturer, whose duties would include some involvement with undergradate courses, but whose main responsibility would be the organisation and marketing of short in-career courses for industrial personnel. The courses are likely to involve lecturers from both the Faculty and industry.

Industrial experience, and an interest in modern methods of communication, would be important attributes. The appointment is a temporary one, for three years, and is on the Lecturer scale, £5052-£10 484 p.a. (from 1 April, under review).

Letters of application together with a curriculum vitae stating age, qualifications and experience and including the names and addresses of three referees should be sent to arrive not later than 14 April, 1980, to the Registrar and Secretary, Senate House, Tyndall Avenue, Bristol BS8 1TH (quoting reference JPB) from whom further particulars may be obtained.

UNIVERSITY OF LONDON GOLDSMITHS' COLLEGE

Physics Department

TECHNICIAN GRADE 4 (PHYSICS AND ASTRONOMY)

Applications are invited for the post of Technician Grade 4 in the Physics Department to start as soon as possible.

The applicant should have relevant qualifications and experience in Physics together with a special interest in Astronomy.

Salary (under review) on scale £4488 x five increments to £5046 inclusive of London Allowance.

Write for further details to the Personnel Officer, University of London Goldsmiths' College, New Cross, London SE14 6NW. Closing date for applications 28 March, 1980.

CHEMISTS

Harry Stanger Limited, the UK's largest Materials Consultancy specialising in services to the Construction Industry require additional staff for their Chemical Department at their Elstree laboratories.

At present vacancies exist for chemists at levels up to graduate standard with leanings towards practical organic chemistry.

For Senior Chemists experience with building materials and familiarity with Infra-red spectroscopy and problem solving would be an advantage. Ability to prepare clear and concise reports would be expected.

For Chemist, or Assistant Chemist positions, applicants would be expected to have achieved a recognised standard (HNC, HND or GCE) and ideally have some knowledge of construction materials. An interest in the chemistry of bitumens and bituminous products would be advantageous.

The company has a progressive attitude to further study and day-release facilities would be considered for suitable applicants.

Fringe benefits include luncheon vouchers, Sports and Social Club and a contributory Pension Scheme.

Application forms may be obtained from the Department Secretary.

HARRY STANGER

THE LABORATORIES
FORTUNE LANE
ELSTREE HERTS WD6 3HO
TELEPHONE 01-207 3191

Sales Representative

Baird & Tatlock (London) Ltd, who are a leading laboratory supplies Company in the U.K., require a sales representative for the West Midlands.

The territory is well established and we are looking for candidates with selling experience coupled with a scientific background to maintain and develop the area.

We offer a competitive salary, bonus scheme, company car and generous fringe benefits.

Applications with a detailed c.v. should be sent to:-
Mr. R. A. Jennings, Baird & Tatlock (London) Ltd., Freshwater Road, Chadwell Heath, Essex, RM1 1HA.

ROYAL POSTGRADUATE MEDICAL SCHOOL

Department of Medicine

TECHNICIAN/ SCIENTIFIC OFFICER

required immediately to join a small team involved in research into metabolic and alimentary hormones.

Salary up to £4551 plus £354 London Allowance a year, initial placing dependent on experience and qualifications. Applicants should hold a degree or equivalent.

Application forms and further details may be obtained from the Personnel Office, Royal Postgraduate Medical School, 150 Du Cane Road, London W12 0HS quoting ref no: 2/271/NS.

MEDICAL REPS

Science graduates 1980

If you are graduating this summer with a science degree and looking for a career position, with excellent salary, a car and good incentives, please telephone or write immediately to: **Ann Finlay, Ridgway House, 41 King William St, London EC4 R9EN.**

Vacancies all over the U.K.

Numerical Modeller

An honours graduate is required to fill a vacancy in the Centre's Resource Modelling Section, based at the Medmenham Laboratory. Candidates must have a degree in mathematics, engineering or a related subject and have experience of computing and numerical modelling techniques.

The successful applicant will apply his or her skills to developing computer models for resource evaluation, particularly to the prediction of water quality in groundwater and surface reservoirs. Present work includes operational research studies on multi-source projects, models of pollutant movements in aquifers and software developments for real-time river-flow forecasting and system control.

Salary, depending on age and experience, will be in range £3,806 – £5,815 and £5,403 – £7,141 (Grades 4 & 3, equivalent to SO & HSO respectively in the Civil Service). Good conditions of employment and a contributory pension scheme. Assistance with relocation expenses may be available.

Please write or telephone for an application form, to be returnable by 4 April quoting post no. 301 to: Personnel Department, Water Research Centre, P.O. Box 16, Henley Road, Medmenham, Marlow, Bucks SL7 2HD. Tel: Hambleden (049 166) 531.

WRC

CHARACTERISATION OF ELECTRONIC MATERIALS BY X-RAY DIFFRACTION

A vacancy exists in the Crystallography Group of the GEC Hirst Research Centre for a graduate to assist in the development and application of X-ray diffraction techniques for the characterisation of electronic materials. Short and long term investigations of a wide variety of poly and single crystals are undertaken.

Graduate applicants, of either sex, should have a basic, but not necessarily detached, understanding of X-ray diffraction procedures: full training will be given. Postgraduate applicants would be expected to have relevant experience. An interest in electronics would be an advantage.

Please apply, giving brief details, to: G. D. Prichard, Administration Manager, Ref: P/053, GEC Hirst Research Centre, East Lane, Wembley, Middx HA9 7PP.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL

JUNIOR TECHNICIAN

required to work in the Department of Clinical Haematology. Minimum qualifications, 'O' level in Science and Maths. Salary according to Whitley Council scale. Please apply in writing to the Secretary, UCH Medical School, University Street, London WC1E 6JJ, quoting reference JT/CH.

NEW ZEALAND FOREST SERVICE

Scientist:

Production Forestry Division, Forest Research Institute, Rotorua

Applications are invited for the above position. Salary up to $16 861 (NZ) per annum depending on qualifications and experience.

Qualifications desired: PhD with experience in forestry and entomology.

Duties: The initial research project involves work on insect problems of plantation-grown eucalypts.

The appointee will be based at Rotorua, an area providing high outdoor recreational opportunity.

Application forms may be obtained from **Chief Migration Officer, New Zealand High Commission, New Zealand House, Haymarket, London SW1, quoting reference number Imm 2/326/7.**

Closing date is 9 May, 1980.

Further particulars if required may be obtained from the **Director, Production Forestry Division, Forest Research Institute, Private Bag, Rotorua, New Zealand. Please quote vacancy No. 9/79/6122.**

UNIVERSITY OF RHODESIA

Applications are invited for the following posts:

LECTURESHIPS/ SENIOR LECTURESHIPS

LAND USE STUDIES: Applicants should have appropriate qualifications to teach both undergraduate and postgraduate courses in land use studies in the Department of Land Management. Postgraduate experience required preferably in Southern or Central Africa. The appointee will join a multidisciplinary team working on the critical problems of land-use in Zimbabwe and will be expected to initiate research of value to policy-makers in agriculture and natural resource management.

Closing date: **15 April 1980.**

SOIL CHEMISTRY OR SOIL PHYSICS: Applicants should have appropriate qualifications to teach and conduct research in either Soil Chemistry or Soil Physics in the Department of Land management. The appointee will be expected to contribute to soil courses at the undergraduate level and to develop postgraduate teaching in his/her area of expertise. The candidate will be expected to initiate research of value to the peasant or subsistence agricultural sector and to contribute to multidisciplinary studies within the Department of the University.

A short-term sabbatical appointment of an experienced soil scientist interested in setting up a postgraduate programme in soils research appropriate to the needs of a developing country would be considered.

Closing date: **15 April, 1980.**

SALARY SCALES (Approx. Stg. equivs.):

Senior Lecturer	£9132 × 343—10 161 × 351 11 916
Lecturer Grade I	£8273 × 343—9645
Lecturer Grade II	£4558 × 328—6198 × 343 —7913

Appointment to the above scales in accordance with qualifications and experience. Both permanent, pensionable terms and short-term one or two year contracts are offered.

Permanent Pensionable Terms: Family passages and allowance towards transport of effects on appointment. Installation loan of up to 25% of one year's salary if required for persons recruited from outside Rhodesia. Unfurnished accommodation is guaranteed for a period of at least three years for persons recruited from outside Rhodesia. Sabbatical and Triennial visits with travel allowances. Superannuation and medical aid schemes.

Short-Term Contracts: Family passages and allowance towards transport of effects. Assistance with accommodation for persons recruited from outside Rhodesia.

APPLICATIONS (Six copies required) giving full personal particulars (including full name, place and date of birth etc), qualifications, employment and experience, publications, present salary, date of availability and the names and addresses of three referees should be submitted to: The Appointments Officer (Staff), University of Rhodesia, P.O. Box MP 167, Mount Pleasant, Salisbury, Rhodesia. Overseas applicants should send an additional copy of their application to the Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF. Please state clearly for which post application is being made.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF PLANT SCIENCES

BIOCHEMICAL PLANT PATHOLOGY

Applications are invited for a post of

RESEARCH FELLOW

to work with Dr J. A. Callow on an ARC-financed project on the recognition of fungal glycoprotein and polysaccharide elicitors of disease resistance by higher plants. The project is a continuation of previous studies and is suitable for those wishing to meet the challenge of an interdisciplinary problem. Experience in one of the following areas is desirable; biochemical plant pathology (especially phytoalexins); lectin, glycoprotein and polysaccharide biochemistry; cellular recognition (animal or plant) but candidates with experience in other areas will be considered. Candidates should already possess, or expect to obtain a PhD degree in the near future.

The appointment is tenable for a fixed period of up to three years with a negotiable starting date.

Salary at an appropriate point on the IA scale for Research and Analogous Staff (£5052–£8769) according to age, qualifications and experience.

Informal enquiries about the post are welcome and may be made through Dr J. A. Callow (Leeds 31751 ext. 6580).

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference number 53/15/E. Closing date for applications 11 April, 1980.

Registration Assistant

Roussel Laboratories, one of the leading pharmaceutical companies in the UK, manufacture and market a range of ethical pharmaceuticals and allied products.

The world-wide distribution of these medical products could not be undertaken without their prior registration. This is the vital task performed by the Registration Section, within our Medical Department, based at Wembley Park. We are currently seeking a Registration Assistant, a science graduate with similar experience, who will assist in obtaining and maintaining the registration of all our products – in the UK and throughout the world. You will possess a patient and unflappable temperament allied to a keen eye for detail. A knowledge of French would be useful.

In addition to a good salary, you will receive a generous range of benefits. For an application form please telephone Helen Auty on 01-903 1454 or send brief details to her at Roussel Laboratories Limited, Roussel House, Wembley Park, Middlesex HA9 0NF.

ROUSSEL

Technician

Chemistry

G. D. Searle is a leading pharmaceutical company with its U.K. headquarters situated in pleasant surroundings at High Wycombe in Buckinghamshire.

A Technician is required to work on synthetic organic chemistry, particularly in relation to our expanding programme of gene synthesis. This position will give the successful applicant valuable experience in molecular biology and other new areas.

Candidates should be qualified or part-qualified to HNC or equivalent level. Alternatively applicants with science 'A' levels and several years' relevant experience would be considered. Day release facilities could be available, and will be discussed at interview.

We offer a good salary, and conditions of employment include 4 weeks' holiday per year, contributory pension and private medical schemes, subsidised cafeteria, and sports and social club.

Please apply in the first instance to Miss D. Wardman, Assistant Personnel Officer, Searle Research & Development, Lane End Road, High Wycombe, Bucks. Tel. High Wycombe 21124, ext. 3374). Please quote reference PF/T/R25.

SEARLE

UNIVERSITY OF WARWICK

LECTURESHIP IN MATHEMATICAL ENGINEERING

Applications are invited for a Lectureship in the Department of Engineering, tenable from 1 October, 1980. Candidates should have a good honours degree, industrial or research experience and research and teaching interests in mathematics applied to engineering. The appointment will be on the Lecturer scale: £5052-£10 484 per annum (under review), but initially not above £6736 per annum. Further particulars and application forms from the Academic Registrar, University of Warwick, Coventry CV4 7AL quoting ref no: 30/2A/80. Telephone enquiries—0203 24011 ext 2627. Closing date for receipt of applications 11 April, 1980.

UNIVERSITY OF SOUTHAMPTON

CHAIR OF MICROPROCESSOR-APPLICATION ENGINEERING

Applications are invited for the Chair of Microprocessor-Application Engineering within the Department of Electronics. Applicants should have experience or interests in the use of microprocessors and will be expected to encourage collaboration in microprocessor teaching and research across the University.

Further particulars may be obtained from the Secretary and Registrar, The University, Southampton SO9 5NH, and applications (10 copies from applicants in the United Kingdom) must be submitted before 30 April, 1980. Please quote Reference NS.

UNIVERSITY OF SOUTHAMPTON

Chemistry Department

ELECTROCHEMISTRY AND ELECTROCHEMICAL ENGINEERING

Applications are invited from suitably qualified people for postgraduate and post-doctoral research in fields including fundamental studies on interfaces, organic electrochemistry, metal deposition, mathematical modelling of electrochemical reactors and battery systems, mixing in electrochemical cells, bubble-evolving electrodes and the design, construction and running of small pilot plants.

Salaries within range £4402-£5052 (postgraduate level) and £5052-£5725 per annum (post-doctoral level).

Applicants should send a curriculum vitae, together with the names and addresses of two referees to Dr R. E. W. Jansson, Chemistry Department, The University, Southampton SO9 5NH. Please quote reference: NS.

ANALYTICAL INVESTIGATORS

Persons with a chemical background and preferably some column-chromatographic experience are wanted for challenging contract work and research, especially on trace-organics in biological fluids and environmental samples. The posts (unestablished) will be at Research Officer level, or possibly Technician level in the case of a junior person, within the Wolfson Bioanalytical Unit of the Institute of Industrial & Environmental Health & Safety, University of Surrey, Guildford GU2 5XH. Information from Dr E. Reid (Head of Unit).

UNIVERSITY OF LIVERPOOL

Bio-Mechanics and Medical Physics Unit

Applications are invited for the post of

LECTURER

in the Bio-Mechanics and Medical Physics Unit. The post involves research in Biomechanics in conjunction with clinical staff of the Liverpool Teaching Hospitals and Medical School. It may also involve the supervision of mechanical workshop facilities for the Medical School.

The Unit has current research activities including biomaterials, prosthetic devices, electronics and computing, and is due to move into new accommodation in the Royal Liverpool Hospital later this year.

Applicants should have a degree or equivalent in mechanical engineering together with experience relevant to this post. Interested graduates of other related disciplines are also invited to contact the Unit for further information. (Tel: 051-709 6022 ext 2292.)

The salary will be on the scale £5052-£10 484 per annum.

Applications, together with the names of three referees should be received not later than 16 April, 1980 by the Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote ref: RV/951/NS.

UNIVERSITY OF STRATHCLYDE

Applications are invited for a

Research Assistantship

concerned with Food Fermentation Technology to be held partly in the DEPARTMENT OF APPLIED MICROBIOLOGY and partly in the CENTRE FOR INDUSTRIAL INNOVATION. Applicants should either be graduates in Microbiology, Biochemistry, Food Science or an associated discipline, or possess an HNC and relevant experience.

The Research Assistant will work with an established research team which has developed improved processes for the production of soy sauce and other fermented foods and seeks now to develop these processes to industrial level to bring the project to commercial fulfilment. In addition, the Research Assistant will also participate in the further development of continuous fermentation processes.

The appointment, which is funded by the Wolfson Foundation is for three years and will be on Range IB of the national salary structure for research and analogous staff. Commencing salary will be on the scale £4402–£5725 per annum (from 1 April 1980) with placing according to qualifications and experience. Superannuation benefit.

Applications with the names of two referees (quoting R21/80) should be sent to **Dr B. J. B. Wood, Department of Applied Microbiology, University of Strathclyde, Royal College Building, 204 George Street, Glasgow G1 1XW from whom further information can be obtained.**

Materials Scientist/Chemist

EMI Electronics Ltd., has an immediate need for Chemists or Materials Scientists to join a successful team at their Feltham laboratories.

The work is extremely varied and demanding, and the successful candidates will have ample opportunity to demonstrate personal initiative and to develop their careers within the laboratories.

The work undertaken includes the evaluation of materials for use in electronic equipment and the development of components and parts essential to such designs. Research is undertaken into long term reliability of materials, and on materials and finishes which are specified for protection of equipment against adverse environments.

There will be involvement with design teams on major projects and a share of the responsibility for ensuring that the high standard of design work is effectively translated into efficient manufacturing practice through the application of stringent quality control procedures.

Applicants should hold an honours degree in Chemistry or other materials-related scientific discipline. Previous industrial experience in related fields such as polyurethanes, epoxy resins, silicones, printed circuit fabrication or thin film technology would be an advantage, but is less important than personal qualities since all necessary training will be given. New graduates are welcome to apply.

In addition to competitive salaries, EMI offers the substantial fringe benefits to be expected of a major international company, including generous relocation expenses where appropriate.

To apply, write to, Stephen Crowther, Personnel Officer,
EMI Electronics Ltd., Victoria Road, Feltham, Middlesex.
Telephone 01-751 0702.

EMI **EMI Electronics Limited, Feltham.**

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CHELSEA COLLEGE
University of London

A COMPUTING TECHNICIAN (GRADE 5)

is required to maintain computer terminals, data communications equipment and related computer room hardware. There will be scope for the design and development of prototype equipment, and for work in the Centre's Microprocessor Systems Laboratory.

Candidates should have HNC Electronics or Full Technological Certificate or an equivalent qualification, together with some experience of terminal servicing.

Salary, from 1 April, 1980, is in the range £5037-£5754 per annum, inclusive (under review).

Further information and application forms can be obtained from Secretary, Computing Centre, Chelsea College, Pulton Place, London SW6 5PR. Telephone: 01-736 1244.

W J Cairns & Partners
Environmental Consultants
Urban and Regional Planners
Architects and Landscape Architects

SENIOR ECOLOGIST

Our Environmental Planning Unit based in the Edinburgh office has a vacancy for a Senior Ecologist. The holder of this post is to provide applied specialist support in environmental planning and design feasibility studies together with the co-ordination of scientific investigations undertaken in-house or by external teams. Experience in environmental impact assessment would be an advantage. PhD or MSc essential.

Placing will be within the professional and senior scale up to £8125 pa according to age, experience and qualifications.

Application with full Curriculum Vitae to,
W. J. Cairns and Partners
16 Randolph Crescent
Edinburgh EH3 7TT
Tel: 031 225 3241. Telex 72277.

THE UNIVERSITY OF LEEDS

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the post of

RESEARCH ENGINEER or RESEARCH ASSISTANT

in the above Department. Candidates should have a good honours degree in an engineering subject and, preferably, a postgraduate qualification or experience in a relevant subject, although applications from candidates with less experience will also be considered.

The successful candidate will work on an Agricultural Research Council funded project on the dynamics of farm transport vehicles. The work is aimed at optimising the design of the suspension, steering and braking systems of a novel vehicle which will be used as an off-road load carrier on farms. Mathematical simulation of vehicle performance on an interactive computer system and experimental measurements on a prototype vehicle will be involved.

The appointment will be made for a fixed period of up to three years.

Salary at an appropriate point on the IA Range for Research and Analogous Staff (Research Engineer) £5052–£8769, or the IB Range for Research and Analogous Staff (Research Assistant) – £4402–£6399 according to age, qualifications and experience.

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference number 69/4/E. Closing date for applications 30 April, 1980.

UNIVERSITY OF SURREY
Department of Physics

LECTURER IN EXPERIMENTAL PHYSICS

Applications are invited for a three year appointment as Lecturer in the Department of Physics commencing 1 October, 1980. Applicants should be experimental physicists with a research background in an appropriate area of classical physics. The successful candidate will be required to help in the development of a new undergraduate course in Physics with Microcomputing. A knowledge of microcomputing and some experience in the applications of microprocessors in experimental physics will therefore be an advantage. In addition the lecturer will be expected to contribute to the general teaching in the Physics and Physics with Musical Acoustics Degree courses. Facilities are available for conducting research.

Salary will be within range £5052-£10 484 per annum (from 1 April, 1980) according to qualifications and experience. Superannuation is under USS conditions.

Further particulars may be obtained from the Academic Registrar (LFG), University of Surrey, Guildford, Surrey GU2 5XH (tel: Guildford 71281 ext 452). Applications in the form of a curriculum vitae, including the names and addresses of two referees, should be sent to the above by 11 April, 1980.

UNIVERSITY OF BRISTOL

IMPERIAL GROUP CHAIR IN MICROELECTRONICS

The University invites applications for appointment to the Imperial Group Chair in Microelectronics funded by the Imperial Group Ltd. The Chair will be within the Department of Electrical and Electronic Engineering.

Candidates are invited to submit applications, including the names of three referees, not later than 14 April, 1980, to the Registrar and Secretary of the University, Senate House, Bristol BS8 1TH, from whom further particulars may be obtained.

R&D MANAGER

Analytical Services

Our Company is part of Engelhard Minerals & Chemicals, the international Precious Metals Group.

Reporting to the Technical Manager for the R&D effort within the new Analytical Services Laboratories, the person appointed will identify and introduce new analytical techniques into the laboratories related to the future needs and diversification of the Company's activities.

This is a new appointment within our management team, offering excellent scope for career advancement, which will be of interest to persons 27/32 years, with an honours degree in Chemistry and post graduate experience in R&D.

Salary is negotiable. Generous relocation assistance is available and other benefits are in line with a successful modern company.

Write in strict confidence with brief career details to date and qualifications, or telephone for an informal discussion:

P. J. Wells,
Personnel Services Director,
The Sheffield Smelting Co. Ltd.,
Windsor Street,
Sheffield S4 7WD.

Tel: 20966

ENGELHARD
Sheffield Smelting

Biochemist

We are looking for a Biochemist to work in a multi-disciplinary team engaged on research into therapeutic approaches to thrombosis. Candidates should have a good higher degree and some relevant experience, which might specially be in the enzymology of this or related fields. Alternative experience might be concerned with aspects of blood coagulation, blood products, or fibrinolysis. As important as the background, however, will be the candidate's ability to make a real contribution at an advanced level to the theoretical and practical work of the team.

The job is located in pleasant surroundings at our new Biosciences Research Centre near Epsom, Surrey. A competitive salary is offered together with a range of benefits including non-contributory pension scheme, free life assurance, subsidised staff restaurant and flexible working hours.

For further information and for an application form please write to or telephone the **Site Personnel Manager, Beecham Pharmaceuticals Research Division, Biosciences Research Centre, Great Burgh, 1 Yew Tree Bottom Road, Epsom, Surrey. Telephone: Burgh Heath 53344 Ext. 2207. Closing date 27 March.**

Beecham Pharmaceuticals

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THOMAS DE LA RUE AND COMPANY LIMITED are the world's leaders in Security Printing. Our business is an intriguing combination of rare traditional craftsmanship and advanced scientific technology.

We have vacancies in our high quality team to assist the Head of the Ink Department.

Ink Chemist/Analyst

We are seeking a graduate in Chemistry or Materials Science with at least three years industrial experience to undertake product analysis of currency and security documents and to develop special inks based on the analytical results. The successful candidate will preferably have expertise in both "classical" and modern instrumental analysis.

Research Scientist

A vacancy also exists for a young graduate in one of the above disciplines to carry out work on the development of products and processes in the Ink Research Department.

These are monthly staff appointments. Benefits include attractive salary, free life assurance and BUPA membership, a contributory pension scheme and twenty two days annual holiday. The Research Centre is on a beautiful Thames-side site skirting Maidenhead, with good social, sports and canteen facilities.

If you are interested and would like to discuss either of these opportunities with us, please write to:

The Personnel Officer, Thomas De La Rue and Company Limited, Basingstoke, Hampshire with brief details of your career to date.

Thomas De La Rue

SYNTHETIC CHEMIST

A vacancy exists in the Chemical Research Department for a young Synthetic Organic Chemist, probably aged between 24–28 years.

The work, which has considerable variety, will be concerned with the synthesis of a range of simple organic molecules as well as of metabolites, isotopically labelled compounds and other entities requiring a substantial degree of skill. There are two Graduate assistants to supervise in the work.

It is likely that candidates will have a P.H.D. and possibly post Doctoral experience together with a keen interest and commitment to research.

Please apply to Helen Burnett, Personnel Officer,
Sterling Winthrop, R & D Division,
Edgefield Avenue, Fawdon, Newcastle upon Tyne.
Tel: (0632) 853931

STERLING WINTHROP

Applications are welcome from both men and women.

AEROSOL SPECIALIST

Our Loughborough-based Pharmaceutical Division already enjoys a lead in aerosol formulation with the technology successfully being applied to a variety of ethical and veterinary products.

To maintain this reputation, we are looking for a top-flight technologist of either sex who can offer a sound basic knowledge of the field plus creative flair and an innovative approach to fundamental studies. We also require the personality necessary to lead and motivate a team, and to convey new ideas to marketing, production and medical specialists within the company.

As part of our forward-looking Pharmacy Group and with your own technical support, you will develop aerosol formulations from initial concept right through to production. Encouragement will be given to carry out fundamental studies in aerosol technology ensuring we maintain our reputation as a leader in the field of inhalation therapy. This all adds up to a challenge requiring a degree or equivalent and at least five years' experience in aerosol formulation.

We will provide the salary, terms and conditions reflecting our position as an internationally renowned organisation and generous assistance with relocation expenses where appropriate.

For an application form please contact Bryan Johnston, Personnel Manager, Fisons Limited, Pharmaceutical Division, Bakewell Road, Loughborough, Leics. Tel: 0509 66361.
Please quote reference number 417/ NS

FISONS 1978
PHARMACEUTICAL DIVISION

PLYMOUTH POLYTECHNIC

FACULTY OF SCIENCE

RESEARCH ASSISTANTS

Research Assistantships, tenable at predoctoral or postdoctoral levels are available for the following projects from 1 October, 1980.

Department of Biology

1. STOMATAL MECHANISM
2. GERMINATION REQUIREMENTS OF BURIED SEEDS, WITH PARTICULAR REFERENCE TO WEEDS.
3. MICROSPORIDIOSIS IN MARINE TELEOSTS

Department of Environmental Sciences

4. CHEMICAL REACTIONS IN THE PROCESSING OF SULPHIDE MINERALS
5. CHEMICAL ANALYSIS OF TRACE ELEMENTS AND POSSIBLE CONNECTION IN DEGENERATIVE DISEASE OF THE NERVOUS SYSTEM
6. THE POSSIBLE APPLICATION OF A FIBRE OPTIC ANEMOMETER (FODA) TO CLAYWATER SYSTEMS
7. ASSESSMENT OF THE NITROGEN AND PHOSPHORUS BUDGET OF LOE POOL
8. SEDIMENTOLOGY AND LITHOSTRATIGRAPHY OF THE LYNTON BEDS (LOWER DEVONIAN) OF NORTH DEVON

Department of Geography

9. AN APPLIED INDUSTRIAL GEOGRAPHY OF THE SMALL BUSINESS SECTOR IN DEVON AND CORNWALL

Candidates should have, or expect to obtain this year, a good honours degree in a discipline appropriate to the field of research.

Research Assistants are normally required to register for a higher degree although post doctoral applicants will be considered. Appointments are for a period of two years, with a possibility of a third year (fixed term contract). **Salary will be £3768 for post graduates or £4068 post doctoral or (equivalent) with annual increments of £150.**

Application forms to be returned by **Friday, 28 March, 1980** can be obtained with further particulars from the **Personnel Officer, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA.**

UNIVERSITY OF OXFORD

Department of Experimental Psychology

has a vacancy for a

RESEARCH ASSOCIATE IN NEUROPHYSIOLOGY AND BEHAVIOUR

Applications are invited for this post to work on the activity of single neurons in visual, limbic, and motor areas of the primate brain. The post is appropriate for the post-doctoral scientist with experience in neurophysiology.

The salary is on the RA 1A salary scale, £5052-£8769 (under review).

Applications in writing to Dr E. T. Rolls, Department of Experimental Psychology, South Parks Road, Oxford OX1 3UD, England.

NATIONAL HOSPITALS & INSTITUTE OF NEUROLOGY

SENIOR MLSO FOR MICROBIOLOGY DEPARTMENT

Successful candidate will have special responsibility for cerebrospinal fluid examination and will also be required to take part in research and the emergency on-call rota. Applicants must have HNC in Microbiology and be State Registered and FIMLT. Enquiries to Mr Warner, tel: 01-837 3611, ext 510. Written applications with cv and names and addresses of two referees to Secretary, Institute of Neurology, National Hospital, Queen Square, London WC1N 3BG.

UNIVERSITY COLLEGE CARDIFF

Chemistry Department

RESEARCH TECHNICIAN GRADE 3

Applications are invited from suitably qualified persons for an appointment in Inorganic Chemistry which is funded by NERC. The post involves synthesis and chemical studies of secondary uranium minerals both in the laboratory and in the field.

The appointment will be made for one year in the first instance, with the possibility of renewal and the successful candidate may take up the post immediately. Further information about the post may be obtained from Dr P. A. Williams, Department of Chemistry (tel: 0222 44211 ext 2168). Salary range: Grade T3 £3594-£4092 per annum.

Applications, together with the names and addresses of two referees should be forwarded to the Vice-Principal (Administration) and Registrar, University College, PO Box 78, Cardiff CF1 1XL. Closing date 27 March, 1980. Reference: 1987.

PHYSICS TECHNICIAN

Inclusive salary £3461-£5663 (under review). The successful applicant will be expected to carry out routine preparation, servicing and cleaning of physics equipment used in teaching to 'A' level. Apply with details of qualifications, experience and names of two referees to The Bursar, City of London School, Victoria Embankment, EC4Y 0DL.

THE LONDON HOSPITAL MEDICAL COLLEGE

(University of London)

Diagnostic and Research Virology Department

JUNIOR 'B' MEDICAL LABORATORY SCIENTIFIC OFFICER

Candidates must have two Science 'A' levels or ONC in Medical Laboratory Sciences. The successful applicant will be expected to undertake further training for HNC, and State Registration.

Salary is on Whitley Council Scales according to age and experience.

For appointment to view the Department, telephone Mr M. Withers, Virology Department, The London Hospital Medical College, Turner Street, London E1 2AD. Tel: 01-247 5454, Ext 164.

TECHNICAL LABORATORY SERVICES LIMITED

JMLSO/MLSO-CLINICAL CHEMISTRY

This well equipped laboratory provides a comprehensive pathology service to the private sector of medicine.

Please write with full details to:
LABORATORY MANAGER,
TECHNICAL LABORATORY SERVICES LIMITED
48-50 Bartholomew Close,
London EC1
Telephone: 01-606 0061/2/3/4

UNIVERSITY COLLEGE LONDON

RESEARCH TECHNICIAN GRADE 6

Required for tissue culture laboratory. The post is with a very active research group and requires technical expertise, organisational ability and the capacity to liaise constructively with staff at all levels, postgraduate students and visiting scientists. Research topics include interactions between muscles and nerves and between mast cells and cancer cells. Extensive working experience in tissue culture is essential. Salary in range £5664-£6612 inclusive of London Weighting. Applications in writing, giving two referees, to Mr V. Newbury, Department of Anatomy & Embryology, University College London, Gower Street, WC1E 6BT.

TECHNICIAN (GRADE 3)

required in Departments of Physiology & Biochemistry and Zoology, University of Reading, to work under supervision in small well-equipped mechanical engineering workshop, producing items in variety of materials such as metals, plastic and wood for teaching and research. Some practical experience of basic workshop techniques essential. Salary in scale £3372-£3840 per annum (under review). Apply with names of two referees quoting ref TS 03A to Assistant Bursar (Personnel), Whiteknights, University of Reading, Reading RG6 2AH.

Development Scientist

Crawley, West Sussex.

Mallory Duracell Europe are an expanding international company, specialising in the manufacture of mercury and alkaline cells and batteries for numerous specialist and every-day applications.

We now wish to appoint a Development Scientist in our European R & D Group based at Crawley to be responsible for the evaluation of new materials, components and processes in our range of cells by small experimental production batches.

Applicants should have HNC/BSc qualifications in Chemistry and a minimum of 2 years experience in an R & D Function. Experience in cell technology although desirable is not essential as full training will be given.

First class conditions of employment are offered, together with assistance with re-location expenses, where appropriate.

Please forward full details of experience, or telephone for an application form to: Wendy Martin, Personnel Officer, Mallory Batteries, Limited (NS), Gatwick Road, Crawley, West Sussex. Telephone: Crawley 26041 Extension 37.

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UNIVERSITY OF KHARTOUM—SUDAN

Applications are invited for two posts of

ASSOCIATE PROFESSOR IN DEPARTMENT OF AGRICULTURAL ENGINEERING

One post is in Machine Design, the other in Soil and Water Conservation. Salary Scale: £S5960-£S6749 per annum (£S1=£1·135 sterling). The British Government may provide salary supplementation in range £3312-£5694 per annum (sterling) (reviewed annually and normally tax-free) and associated benefits. Family passages; baggage allowance; superannuation scheme; unfurnished accommodation; various allowances. Detailed applications (2 copies) including curriculum vitae and naming three referees should be sent by airmail, not later than 15 April, 1980, to Personnel Secretary, University of Khartoum, PO Box 321, Khartoum, Sudan. Applicants resident in UK should also send one copy to Inter-University Council, 90-91 Tottenham Court Road, London W1P 0DT. Further details are obtainable from either address.

MEDICAL RESEARCH COUNCIL BLOOD GROUP UNIT

requires

JUNIOR TECHNICIAN OR TECHNICIAN

for general work in blood group serology. The Unit searches for unrecognised blood group antigens and studies the genetical applications of those already known.

Junior Technician should have four 'O' levels and, preferably, two science 'A' levels. Technician should have HNC or degree. Salary according to age and experience.

Apply in writing to Dr Ruth Sanger, Wolfson House, University College London, 4 Stephenson Way, London NW1 2HE.

UNIVERSITY OF LEICESTER

Department of Engineering

RESEARCH ASSOCIATE

Applications are invited from graduates in either engineering or applied mathematics with appropriate research experience and preferably with a higher degree to work on an SRC supported research project concerned with the behaviour of materials and structures at high temperatures. The project is concerned with the development of design methods for nuclear structure and has both theoretical and experimental aspects. If appropriate, the opportunity exists for registration for a PhD degree.

The appointment will be made within the grade (1a) salary scale which commences at £5052 from 1 April, 1980. Applicants should send a curriculum vitae with the name of two referees to Professor Alan R, S. Ponter, Department of Engineering, Leicester University, LE1 7RH, from whom further particulars may be obtained.

UNIVERSITY OF HULL

Department of Physics

SRC RESEARCH ASSISTANTSHIP

Two Research Assistants are required for magneto-optical and transport measurements in semiconductors in order to characterise defects in these materials. Experience in either magnetic resonances, optical spectroscopy or transport measurements would be an advantage. For further details write to Dr B. C. Cavenett.

Salary scale: £5052-£5725 per annum.

Applications giving details of age, qualifications and experience, together with the names of two persons to whom reference may be made, should be sent by 31 March, 1980 to Dr B. C. Cavenett, Department of Physics, University of Hull, Hull HU6 7RX.

Technical Services Manager

Veterinarian

Cyanamid's animal health division, which has achieved substantial business growth with its animal feed additive products, wish to appoint a Veterinarian to join their small but highly successful technical and marketing team based in South Hampshire.

The position will provide a specialised technical advisory service to our customers, require close liaison work with our technical and commercial staff, involve liaison with government departments on registrations and associated matters and provide representation and involvement with specific trade associations.

Suitable candidates, male or female, must be appropriately qualified veterinary surgeons with ability to communicate effectively, preferably have experience with pigs and poultry and a knowledge of the animal feed industry.

A competitive salary, reflecting the background and experience of the successful candidate, will be offered, together with a company car and a first class contributory pension scheme. Generous assistance with relocation will be available if necessary.

Please write or telephone for an application form to:

David G. Taylor, Employment Manager,
Cyanamid of Great Britain Limited,
Fareham Road, Gosport, Hants. PO13 0AS.
Telephone: Fareham (0329) 236131.

CYANAMID

SCOTTISH MARINE BIOLOGICAL ASSOCIATION

MICROBIOLOGIST

A vacancy exists for a microbiologist to work on problems associated with the degradation of organic material in the marine environment. The work involves close co-operation with other scientists working in the laboratory and a strong interest in biogeochemical problems would be expected. In addition the applicant would be expected to supervise several PhD students and maintain close liaison with a number of University departments and contracting organisations. The post is graded as Senior Scientific Officer or Higher Scientific Officer (SSO Salary Scale: £6332-£8705; HSO Salary Scale: £5097-£6737). Application forms and further details may be obtained from:

The Administrative Officer, Dunstaffnage Marine Research Laboratory, PO Box 3, Oban, Argyll PA34 4AD.

Closing date for applications: 28 March, 1980.

University College Hospital

Research in Clinical Instrumentation

Continued support for research and development in the related fields of clinical instrumentation and scientific computing has provided funds for the following posts which are available from 1 April, 1980.

Research Officers/ Physical Scientists

Post 1 To work on problems of collecting and handling laboratory and clinical data. The successful applicant will have a working knowledge of electronics and possibly some experience with small computers. The appointment is for two years in the first instance.

Post 2 To work on the design, construction and testing of prototype equipment principally for use in perinatology. A working knowledge of electronics is essential. The appointment is for one year in the first instance.

Post 3 To work on development of gas detectors using a variety of thin and thick film metal deposition techniques. A knowledge of vacuum equipment and electronics would be useful but not essential. Appointment for one year in the first instance.

Qualifications 1st or 2nd Class Honours Degree in an appropriate science subject.

Salary Scale Basic Grade Scientist £4205–£6473 including London Weighting.

Research Assistant/ Technician

Post 4 To work with the research team on the construction and testing of prototype equipment. Appointment for one year in first instance.

Minimum qualifications ONC or equivalent.

Salary Scale MPT IV £4280–£5504 including London Weighting.

Further particulars from the Director, Department of Medical Physics. Tel: 01 387 9300.

Application forms from Personnel Department, University College Hospital, Gower Street, London WCIE 6AU. Tel: 01-387 9300 Ext. 381.

GRADUATE

required for:

Anthony Nolan Laboratories,
St. Mary Abbot's Hospital,
Marloes Road,
Kensington, London W8.

Duties are mainly tissue typing for bone marrow transplant programme. Knowledge of immunology and tissue typing an advantage.

Remuneration according to age and experience.

Please apply in writing to **Ms Barbara Birchmore** at the above address.

FERNHILL SCHOOL,
FERNBRAE AVENUE,
RUTHERGLEN,
GLASGOW, G73 4SG.
(Tel. 041-634-2674)

Independent Catholic Day School for Girls requires for August 1980, graduate to teach

PHYSICS

either (a) full-time throughout the school
or (b) part-time involving three small classes at Third, Fourth and Fifth Year stage.

An additional responsibility payment will be available for a full-time appointment.

Curriculum vitae and names and addresses of two referees should be sent to the Headmistress from whom further information may be obtained.

TECHNICIAN (GRADE 3)

required in Department of Soil Science, University of Reading, to assist with chemical analysis in research project on behaviour of phosphate in tropical soils. Experience in laboratory analysis and ONC or equivalent qualification necessary. Appointment to 31.2.82. Salary in scale £3372-£3840 per annum (under review). Apply with names of two referees quoting ref TS 12A to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.

TECHNICIAN (GRADE 3)

required in Department of Microbiology, University of Reading to prepare and supply materials for classes and to assist a small group in research on some aspect of Microbiology. Salary in scale £3372-£3840 per annum (under review). Apply with names of two referees quoting ref TS 01A to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading RG6 2AH.

DEPARTMENT OF ELECTRICAL ENGINEERING
THE UNIVERSITY OF ALBERTA

Applications are invited for a

Research Associate

in the area of plasma physics. Some experience in numerical modelling is desirable.

Applications, including curriculum vitae and the names of three referees should be sent to:

Dr C. R. James
Professor and Chairman
Department of
Electrical Engineering
The University of Alberta
Edmonton, Alberta, Canada
T6G 2G7

BURMAH COMPANY

requires a Development Chemist to undertake laboratory formulation work on a range of adhesives, coatings and sealants, specifically for use with the insulation of plant and equipment. Previous experience of polymeric products would be an advantage, but is not essential. The position is suitable for a graduate or a person qualified to HNC standard.

The company is a member of the Burmah Oil Group and is a market leader in insulation protection products. Write giving details of age, qualifications and experience to: The Chief Chemist, Atlas Products & Services Ltd, Fraser Road, Erith, Kent.

Withington Hospital
Nell Lane, Manchester

National (UK) Reference Laboratory for Anticoagulant Reagents and control requires

TWO GRADUATES

in **Biochemistry or a Biological Science** with good class honours degrees.

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LECTURES, MEETINGS AND COURSES

UNIVERSITY OF EAST ANGLIA, NORWICH
School of Biological Sciences

BIOLOGY COURSE FOR TEACHERS

21-25 July, 1980. Suitable for teachers of A-level Biology, participants may take one of three subcourses:
(a) Zoology; (b) Microbiology; (c) Animal ecology.

Further details from **Dr A. P. Dawson, School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ.**

THE UNIVERSITY OF LEEDS

DEPARTMENT OF FUEL AND ENERGY

POSTGRADUATE OPPORTUNITIES

Opportunities for postgraduate work in the above Department are offered in:—

RESEARCH

Combustion of Gaseous, Liquid and Solid Fuels
Fuel Economy and Energy Conservation
Environmental Pollution Control
Fuel Processing and Production of Synthetic Fuels
Fire and Explosion Prevention
Alternative Energy Sources

MSc COURSES

Combustion and Energy
Environmental Pollution Control

POSTGRADUATE DIPLOMA COURSES

Fuel and Energy Engineering
Fuel and Combustion Science

Details from Professor A. Williams, Department of Fuel and Energy, The University, Leeds LS2 9JT.

UNIVERSITY OF STRATHCLYDE

DEPARTMENT OF PURE AND APPLIED CHEMISTRY

M.Sc. IN APPLIED COLLOID AND INTERFACE SCIENCE

This twelve-month postgraduate course by instruction and research is organised in the Department of Pure and Applied Chemistry. The multidisciplinary nature of the subject is reflected in the lecturing staff, drawn from this Department and from the Departments of Pharmaceutical Chemistry, Pharmaceutics and Fibre Science. Lectures are also given by a number of leading industrial scientists and form an integral part of the course work.

The aim is to produce scientists trained in both the fundamental principles of colloid and interface science and the application of these principles to the solution of practical problems. Close contact between the students and industry arises in the form of lectures, visits, laboratory experiments and co-operative research projects.

Candidates seconded from industry who cannot be released by their employers for a whole year to attend the course may, after completion of the instructional part, be allowed to return and pursue an agreed collaborative research project in their employer's laboratories on either a full-time or an extended part-time basis.

Applications are invited from persons who hold an appropriate honours degree or its equivalent. The course is accepted by the Science Research Council for the tenure of its Advanced Course Studentships. Students seconded from industry may be eligible for other SRC studentships which in appropriate circumstances may be supplemented by their employers.

Application forms and copies of the Course Prospectus are available from **Dr D. B. Hough, Department of Pure and Applied Chemistry, Thomas Graham Building, 295 Cathedral Street, Glasgow G1 1XL.**

UMIST

Department of Mathematics

MSc COURSE IN STATISTICS

This MSc taken by examination and dissertation is normally of twelve months' duration, and is organised jointly with the Statistical Laboratory, University of Manchester. Candidates may select topics from a wide range of lecture courses covering both mathematical and applied statistics, and including, in particular, recent developments in the theory and analysis of RANDOM (STOCHASTIC) PROCESSES which underlie the statistical approach to FORECASTING AND CONTROL. The course has been approved by the SRC as suitable for the tenure of their Advanced Course Studentships.

The Statistics Group at UMIST forms part of the Manchester-Sheffield School of Probability and Statistics, and collaborates closely with the other groups in this School.

Suitable candidates can proceed by research to the PhD degree.

For further information, write to:—
Professor M. B. Priestley, Department of Mathematics, UMIST, PO Box 88, Manchester M60 IQD.

A COURSE ON TECHNOLOGICALLY IMPORTANT ASPECTS OF INTERFACE SCIENCE

will be held on 4-13 June, 1980. The course will be a blend of lectures and demonstrations dealing with the fundamental and applied aspects of the subject. Attendance will be limited to 30 participants and is aimed at Scientists and Technologists who wish to increase their awareness of the role of interfacial phenomena in practice.

Further particulars from Professor A. I. Bailey, Department of Chemical Engineering and Chemical Technology, Imperial College of Science and Technology, London SW7.

GRESHAM LECTURES

in Medical Science. The Physiology of Standing by Professor D. Slome. 3 one-hour lectures at The City University, Northampton Square, London EC1. March 14 at 1.00 p.m. and March 21 at 6.00 p.m. **ADMISSION FREE**

Inter-University MSc Course on "The Physics and Technology of Amorphous Materials"

Universities of Dundee - Edinburgh - Glasgow

The one year advanced course, in this rapidly developing field, is offered jointly by the above named Universities. Course work for session 1980-81 will be given at the University of Dundee. For the project work, students will join a research group at one of the participating Institutions.

Applications are invited from students with an honours degree (or its equivalent) in either Physics, Electrical Engineering, Chemistry, or a Materials Science. The course has been approved by the Science Research Council and Advanced Course Studentships are available for suitable qualified applicants.

Further information may be obtained from:

Professor W. E. Spear,
Carnegie Laboratory of Physics,
University of Dundee,
Dundee DD1 4HN

BRUNEL UNIVERSITY

Part-time or Full-time

MSc COURSES IN MATHEMATICS

The following two courses are offered on a part-time basis requiring attendance on one day per week for two years. The courses are also offered on a one year full-time basis. Both courses are designed for students qualified in fields such as mathematics, engineering or physics.

The part-time courses are particularly suitable for mature students in industry or educational establishments who wish to acquire knowledge of modern applicable mathematics.

(1) Numerical Analysis—Topics will include: numerical linear algebra, approximation theory, splines, numerical solution of ordinary and partial differential equations by finite difference and finite element methods, solution of non-linear equations, numerical solution of integral equations, and functional analysis.

Machine problems on the University's computers form an integral part of the course. A course of mathematical modelling is also provided. The full-time course is SRC approved for their Advanced Course Studentships.

(2) Mathematics with Applications—Topics will include: methods; applied algebra; catastrophe theory; control theory; asymptotic analysis; approximation theory and other mathematical topics as well as options in the fields of Systems Engineering, Cybernetics, Digital Systems, Numerical Analysis, Statistics and OR, and Education.

Details of (1) from Dr N. Papamichael, of (2) from Dr A. Rae, Dept of Mathematics, Brunel University, Uxbridge, Middlesex.

PLYMOUTH POLYTECHNIC

MSc Course in Applied Fish Biology

A one year full time course—7 months taught and 5 months research

Form & Function
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Disease
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Further details and application forms from the **Department of Biological Sciences Plymouth Polytechnic, Drake Circus, Plymouth, Devon PL4 8AA. Telephone (0752) 264659.**

UNIVERSITY OF BRISTOL

12 MONTHS MSc COURSES BY ADVANCED STUDY AND RESEARCH

are offered in the following subjects:

- Advanced Analytical Chemistry (Inorganic Chemistry)
- Surface Chemistry and Colloids (Physical Chemistry)
- The Physics of Materials (Physics)
- Mathematical Logic and Foundations of Mathematics (Mathematics)
- Fluid Mechanics (Mathematics)
- Meat Science (School of Veterinary Science, Langford)

All six courses qualify for Research Council studentships. Further details of the individual courses may be obtained from the **Head of the Department** concerned, **University of Bristol, BS8 1TH.** Enquiries are also invited for details of opportunities for research leading to the degree of PhD.

UMIST

RESEARCH IN CORROSION SCIENCE

Applications are invited from candidates possessing, or expecting, a science or engineering degree, or equivalent qualifications, to undertake research in corrosion and protection leading to MSc, or PhD. Financial assistance may be available. The Corrosion and Protection Centre has research groups active in most areas of corrosion and protection.

Applications will also be considered for postgraduate courses in Corrosion Science and Terotechnology.

All applications and enquiries should be addressed to Professor G. C. Wood, Corrosion and Protection Centre, UMIST, P O Box 88, Manchester M60 IQD.

FELLOWSHIPS, GRANTS, SCHOLARSHIPS

Science Research Council

ROYAL GREENWICH OBSERVATORY

RESEARCH FELLOWSHIPS IN ASTRONOMY, ASTROPHYSICS AND OBSERVATIONAL TECHNIQUES

Fellowships tenable for one to three years are available at the Royal Greenwich Observatory. The Observatory pursues numerous research programmes in Extragalactic, Galactic and Solar System astronomy, in the development of Observational techniques including electronic imaging devices and in the application of sophisticated data handling processes to astronomical research. Although the fellowships are for individual research, successful applicants will be expected to participate in the Observatory's programmes and to interact closely with staff members. Successful applicants who wish to follow observational reserch will be able to apply for time on all SRC telescopes including the 3·9m Anglo-Australian Telescope.

The appointment may be at Junior, Senior or Principal Research Fellow level. Candidates should have a good honours degree; for Junior Fellowship candidates must have completed (or be about to complete) a doctoral degree or equivalent. For Senior Fellowships at least one year of research beyond completion of a doctoral degree is required. Principal Research Fellowships are reserved for candidates of the highest scientific calibre who must have achieved an international reputation in their particular research field, and candidates must demonstrate that that they have engaged in fruitful research for a considerable period.

The present stipend ranges are as follows:

Junior Research Fellow	£4545 to £5701
Senior Research Fellow	£6263 to £7712
Principal Research Fellow	£8608 to £11 350

The stipend offered will depend on qualifications and experience.

Application forms, and details of current research programmes of the RGO, are available from Mr N. Jones, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, East Sussex, BN27 1RP, England. Application forms accompanied by a description of the proposed programme of research, must be returned by 25 April 1980.

UNIVERSITY OF ABERDEEN

MILNER SCHOLARSHIPS

Applications are invited for a Milner Scholarship tenable at the University of Aberdeen for research in the Department of Bacteriology. It is likely that the successful candidate will join a research group led by Professor T. H. Pennington investigating the biology of poxviruses and bunyaviruses.

Applicants must hold (or expect to gain in 1980) a good Honours degree in Microbiology, Biochemistry or some other branch of Biology.

The Scholarships, of £1820 per annum or the equivalent of an SED or SRC Studentship, whichever may be the higher, is tenable for one year from October 1980 in the first instance, but is renewable; any fees due from the holder will also be paid and dependant's allowances on the scale approved for SED and SRC Postgraduate Studentships.

Applications (two copies) to Professor T. H. Pennington, Department of Bacteriology, University Medical School, Foresterhill, Aberdeen, stating qualifications and giving names of two referees.

The Trustees of the

MOTT, HAY & ANDERSON CHARITABLE TRUST

are pleased to offer a

SCHOLARSHIP

valued at £4000, tenable for one year, to enable a well qualified candidate to carry out an approved course of post-graduate study or research in engineering. During the academic session 1980-81 the scholarship will be tenable in the Wolfson Bridge Research Unit at the University of Dundee, for a study of adhesive joints as applied to structures.

Depending on experience, the successful applicant, if married or over 24 years of age, may apply for certain additional allowances from the Wolfson Bridge Research Unit.

Further details, and an application form, may be obtained by writing to The Director of the Wolfson Bridge Research Unit, Civil Engineering Department, University of Dundee, Dundee DD1 4HN; or to The Secretary, Mott, Hay & Anderson Charitable Trust, 20-26 Wellesley Road, Croydon, CR9 2UL.

Applications must reach the Director of the Research Unit in Dundee not later than 11 April.

UNIVERSITY OF WARWICK

POSTDOCTORAL FELLOWSHIP IN BIOLOGICAL SCIENCES

Applications are invited for the position of Postdoctoral Fellow to investigate the potential use of methane-oxidising organisms and the enzyme methane monooxygenase in industrially important catalytic conversions. The post is available immediately, but applications from those who could start in October 1980 will also be considered. Initial salary will be up to £6062 per annum on the Research Range 1A scale: (from 1 April, 1980) £5052-£8769 per annum. Graduates with experience in Microbiology, Biochemistry or Chemistry should apply to the Academic Registrar, University of Warwick, Coventry CV4 7AL quoting ref no: 30/A/80 from whom application forms and further details of the project may be obtained.

UNIVERSITY OF BIRMINGHAM

Department of Chemical Engineering

RESEARCH FELLOWSHIP

Applications are invited for an SRC-funded post-doctoral research fellowship to work on mixing, gas-liquid mass transfer and rheology. The work is particularly related to the fermentation of Xanthan gum. Experience in fluid mixing processes in agitated vessels and/or rheology is desirable.

The post is tenable immediately until 31 December, 1982. Salary on Research Fellow 1A scale £5052-£8769 (April scales), plus superannuation. Maximum starting salary £5725.

Further particulars available on request from the Department of Chemical Engineering.

Applications (three copies), including full curriculum vitae and naming three referees to the Assistant Registrar, Science and Engineering, University of Birmingham, PO Box 363, Birmingham B15 2TT by Friday 28 March, 1980.

Please quote ref: NST1.

UNIVERSITY OF STRATHCLYDE

Applications are invited from chemists, physicists or materials scientists for a **Postdoctoral Research Fellowship** in the **Department of Pure and Applied Chemistry** to investigate the role of lattice defects in crystallisation processes. The work, which will combine defect characterisation by X-ray topography with kinetic growth studies, is directed towards an understanding of the anomalous growth of secondary nuclei from saturated solutions. The post is sponsored by the I.C.I. Joint Research Scheme and will involve a collaborative programme between this laboratory, the I.C.I. Corporate Laboratory and the Dept. of Chemical Engineering, University College, London.

Commencing salary £5725—£6379 per annum (from 1 April 1980) on Range IA of the national salary structure for research and analogous staff, with placing according to age and experience. Superannuation benefit. The appointment which will be for up to three years will commence at any mutually convenient time.

Application, curriculum vitae and names of two referees (quoting R17/80) should be sent to **Professor J. N. Sherwood, Department of Pure and Applied Chemistry, University of Strathclyde, Thomas Graham Building, Glasgow, G1 1XL.**

THE ROYAL SOCIETY

LOCKE RESEARCH FELLOWSHIP

HOWE RESEARCH FELLOWSHIP

Applications are invited for a Locke Research Fellowship for experimental physiology and pharmacology and a Howe Research Fellowship for immunology. Tenure (for the Howe restricted to places in the United Kingdom) is for three years from 1 October, 1980; the Locke may be renewed for a further two. Applicants (for the Howe restricted to citizens of the United Kingdom or the Commonwealth) must have a PhD or equivalent research experience; they should preferably be under 33 on 1 October, 1980, for the Locke and under 26 on 1 October, 1980, for the Howe. Current stipend scales (under review) are £7011×£294 to £8481 for the Locke and £4998×£288 to £6438 for the Howe, with superannuation benefits. Forms obtainable (state for which fellowship) from The Executive Secretary, The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG, must be returned by 15 April, 1980.

QUEEN MARY COLLEGE

University of London

Laser Measurement of Bovine Spermatozoa Motility

Applications are invited for a two-year Postdoctoral

RESEARCH FELLOWSHIP

to work with Dr D. A. Ross, in conjunction with the Ministry of Agriculture Cattle Breeding Centre, Reading, to verify the viability of routine assessment of samples of frozen semen using the new fibre optic Doppler anemometer, and to corelate motility measurements with fertility trials. Candidates should have a PhD in a Biological Science, Physics or Electronic Engineering and an interest in an interdisciplinary research project. Initial salary in range £5792-£6465 per annum (including London Allowance). Please apply, giving age, qualifications, experience and names of two referees to The Secretary, (NS) Queen Mary College, Mile End Road, London E1 4NS.

THE UNIVERSITY OF SHEFFIELD

POSTDOCTORAL RESEARCH FELLOWSHIP

Applications are invited from men and women for an SRC Fellowship to work in collaboration with Dr G. M. Blackburn on the synthesis of analogues of biological phosphate esters. The interaction between the analogues and enzymes will be investigated especially using very high resolution n.m.r. spectroscopy. Tenable for one year from 1 October, 1980. Initial salary in range £5052–£5725 a year. Applications, including a curriculum vitae and the names of two referees, to **Dr G. M. Blackburn, Department of Chemistry, The University, Sheffield S3 7HF,** as soon as possible. Further particulars available on request. Quote Ref: R422/H.

STUDENTSHIPS

NATIONAL VEGETABLE RESEARCH STATION

ARC RESEARCH STUDENTSHIP

Applications are invited for an Agricultural Research Council postgraduate Studentship for research on the biochemical basis of resistance to bean common mosaic virus in Phaseolus vulgaris. The work will involve laboratory and glasshouse studies, and will be under the supervision of Dr R. S. S. Fraser.

The studentship will be tenable from 1 October 1980 for up to three years at the NVRS with a view to reading for the degree of PhD. Candidates should hold or expect to obtain in 1980 a first or upper second class Honours degree in Biochemistry or Plant Science, with particular emphasis on at least one of the following disciplines: plant biochemistry, virology and genetics.

Further particulars and an application form (to be returned by 25 March 1980) from the Secretary, National Vegetable Research Station, Wellesbourne, Warwick CV35 9EF.

THE UNIVERSITY OF MANCHESTER

Applications are invited from graduates or those expecting to graduate in 1980 for

RESEARCH STUDENTSHIPS IN SCIENCE AND MEDICINE

Value as for SRC studentships, normally renewable after first year. Particulars and application forms (returnable by 2 June) from the Registrar, The University, Manchester M13 9PL. Quote ref: 33/80/NS.

HILL FARMING RESEARCH ORGANISATION

AIR RESEARCH STUDENTSHIP

Applications are invited for an Agricultural Research Council Studentship tenable for three years from 1 October, 1980 at the Hill Farming Research Organisation for research leading to a higher degree.

The research topic to be investigated concerns factors which affect nodulation of white clover growing in hill soils by rhizobia.

Applicants should possess, or expect to obtain, a 1st or upper 2nd class honours degree in Microbiology or a related subject.

The award comprises a tax free maintenance allowance according to circumstances (£1820 for a single person living in rented accommodation), approved university fees, some travelling expenses and dependent allowances where appropriate.

Further details and application forms may be obtained from the **Secretary, Hill Farming Research Organisation, Bush Estate, Penicuik, Midlothian EH26 0PY.** Applications should be returned by 5 April, 1980.

IMPERIAL COLLEGE

Nuclear Energy Research

Several PhD Studentships will be available, for well qualified graduates, for research into environmental aspects of nuclear power. Projects include neutron physics applied to shielding and waste management and the computer simulation of radionuclides in the environment. Apply for details to Professor P. J. Grant, Mechanical Engineering Department, Imperial College of Science and Technology, Exhibition Road, London SW7 2BX.

UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH

WELSH PLANT BREEDING STATION

ARC RESEARCH STUDENTSHIP

Applications are invited for an ARC Research Studentship tenable for three years from September/October 1980 on *one* of the following research topics:

1. Host-nematode relationships of clovers and clover cyst-nematode.
   (Supervisor: Dr R. Cook)
2. Export of carbon and nitrogen in relation to leaf development in the temperate Gramineae.
   (Supervisors: Dr Howard Thomas and Dr C. J. Pollock)
3. Competitive interactions in herbage crops.
   (Supervisor: Dr J. Hill)
4. Studies of chromosome manipulation and gene transfer in *Avena*.
   (Supervisor: Dr Hugh Thomas)

The candidate, who should possess or expect to gain a good Honours degree in a relevant discipline, will be registered with the University of Wales for a higher degree.

Applications, including the names of two referees, should be sent on or before 18 April 1980 to **The Secretary, Welsh Plant Breeding Station, Plas Gogerddan, Aberystwyth, Dyfed, SY23 3EB,** from whom further particulars can be obtained.

UWIST

University of Wales

DEPARTMENT OF TOWN PLANNING

SSRC LINKED STUDENTSHIP IN STRUCTURAL MODELS OF THE DESIGN PROCESS

Applications are invited for an SSRC research studentship linked to Professor Michael Batty's research in design methods and theory in the planning process.

Application forms and further details are available from The Assistant Registrar, UWIST, 2 Museum Place, Cardiff CF1 3BG.

BEDFORD COLLEGE

(University of London)

Department of Geography and The Building Research Establishment

RESEARCH STUDENTSHIP

Available for three years to investigate mechanisms of limestone decay in urban buildings, Funded by the Building Research Establishment, the award is comparable to a CASE award of the NERC. Applications to (and further details from) Professor R. U. Cooke, Bedford College, Regent's Park, London NW1 4NS, by 27 March, 1980.

Bedfordshire Education Service

LUTON COLLEGE of Higher Education

RESEARCH STUDENTSHIP

Applications are invited from persons holding or expecting to obtain a good Honours Degree in Microbiology or Biochemistry to join a team investigating aspects of the microbiology and biochemistry of the thermophilic and mesophilic digestion of industrial organic wastes. Applications enclosing a curriculum vitae should be addressed to **Mr J. C. E. Howard, Head of Department of Science, LCHE, Park Square, Luton.**

BOOKS

IS JUPITER A DECAYED NEUTRON STAR?

Radical new theory for the birth of our Solar System. Copies and price on application from Jess Artem, 18 Russell Garden Mews, London W14.

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required on Biological and Earth Sciences, Natural History, Agriculture and Horticulture. Morgan, Heulwen, Castle Gardens, Hay-on-Wye, Hereford.

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issues from April 1958-December 1976 inclusive. Enquiries to the Librarian, ATV Network Ltd, Tel: 01-953 6100, ext 2345.

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One year full-time course specialising in the preparation, structure and properties of a range of materials such as glasses, polymers, ceramics, etc. with particular reference to the opto-electronic, electronic and polymer industries which offer a wide range of employment opportunities.

Applications are invited from honours graduates or final-year students in chemistry, physics and materials science.

Apply to Head of School of Materials Science and Physics, Thames Polytechnic, Wellington Street, London, SE18 6PF. Telephone: 01-854-2030 Extension 282.

UNIVERSITY OF OXFORD

Dyson Perrins Laboratory (Organic Chemistry)

Applications are invited for an

SRC-CASE AWARD

tenable from next September concerned with the synthesis and microbiological oxidation of sesquiterpenes in collaboration with Schweppes Limited.

Applications with details of career and the names of two referees should be sent as soon as possible to Dr T. G. Halsall, Dyson Perrins Laboratory, South Parks Road, Oxford OX1 3QY.

PERSONAL

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is the freezing of people when they die. If all your memories are preserved the next problem will be revival. This problem has now also been solved. For details write to The Cryonics Society of Great Britain, 53 Clarendon Road, Wallasey, Merseyside L44 8EJ.

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Ariadne

■ I have always imagined that the English were the most barbarous lot in the world about trees in towns. Perhaps not, for the admirable code of practice for trees in relation to construction from the British Standards Institution (BS5837:1980), translates its title into French and German. So there may be French and German builders accidentally smashing down trees with lorries, unfortunately stripping branches off with pallet trucks and uprooting trees of 20 years growth from a regrettable misunderstanding of instructions.

The BSI's booklet contains information that builders and architects ought to know and would be advantageous for anyone trying to preserve trees to know too.

It's all about what kind of trees to plant and how to look after them, as well as how to keep them alive if they're there already. Infuriatingly, it's not possible to mount guard on young trees round the clock. So their survival is something of a miracle. Where I live, they are ripped, used as goal posts or totem poles, beheaded and torn out of the ground and their wire protection used as giant rubbish bins.

■ It's as easy as wink, as falling off a log but in the US it's as easy as taking candy from a baby or, if you believe advertisements, as easy as grasping a glass of orange juice. The orange juice idea is new to me, but that's what it says in a plug for Insta-Pulse, the heart rate monitor you can use in your own home (or anywhere else).

No waiting, for as soon as Insta-Pulse is in your hands it reads your heart rate function from the tiny electrical impulses in your fingertips. Instantly you will see how the most critical organ of your body responds to exertion. There is a lot more of this, including the attractive prospect of learning to alter your heart rate at will. Grasping a glass of orange juice must be a special technique in the US, according to the advertisement, though. The Insta-Pulse, shaped like a rod, is held like the handlebars of a bicycle. In Britain the juice would fall out.

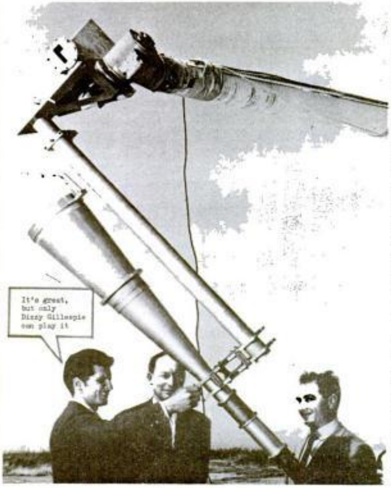
Still, you needn't stay with that model. Another advertisement tells about the Pulse Rate Monitor. With this, finding out your heart rate is not only important, it can be fun, too. It's small enough to comfortably carry with you to parties or anywhere. You stick your finger into this. A beam of infrared is shone on to the finger and the detection of surges of blood gives the information to the finger sticker.

This exciting new product is offered exclusively by mail. The coupon you have to fill in (out) says, "Please rush me . . . Pulse Rate monitor(s) . . ." I think that before you get into such drama you ought to check your heart rate. Maybe you really need a coupon that moves at a reasonable pace.

■ One of the more endearing characters in the novels of Somerset Maugham has a three-month supply of *The Times* sent out to him regularly. Such is his devotion that he reads one paper a day, even though it is during the First World War and colossal battles have raged and ended in the period they cover.

Some years ago I met a man who had been in the Far East when Maugham was travelling there. He claimed to have known the man that Maugham described and was amused at the indignation shown by the people who had entertained the author when they found themselves running and jumping in stories that were published later.

What a time the character with *The Times* could have had now. For all I know, someone may be following the same policy, only with modern developments. There he would sit in his Borneo hut, with a pile of TV tapes, recordings of every instalment of *Tinker, Tailor, Soldier, Spy* or the latest Francis Durbridge; perhaps, if he were of a strong disposition, recordings of the party political broadcasts, in sequence. Only this time, pictures being the attraction they are, I expect that he would be surrounded by natives anxious to get a glimpse at the screen, as soon as the generator started up. Cries of "Telly, tuan!" all round and ugly scenes at fade-out. "Back, you dogs! First man to touch rewind will feel the lash, I tell you."



■ The ultimate snapshot camera, says my photoleptic friend Daedalus, would be your own eye with film in it. Seeking the next best thing, he has invented a little optical probe mounted on spectacle frames and peeping into the pupil. It has a concave lens exactly countering the eye-lens, and thus views the retina (and any scene imaged upon it) as if through a plane window. The probe is only a millimetre across and so does not obstruct the eye unduly; the wearer hardly notices the tiny stalk on his glasses so close as to be quite out of focus. At first Daedalus was worried about the rapid movements of the eye, but soon realised that while the eye scans around, the image on the retina remains still. The scanning merely moves the sensitive part of the retina around the image, "sampling" it for the brain to study. The automatic focusing of the eye means that the probe always sees a sharp image; but its feeble light-grasp remains a problem. Daedalus intends to make the probe a tiny camera itself, focusing upon a fine optic-fibre bundle that takes the image away to a pocket-pack where a channel-plate photomultiplier can amplify it up and record it on film. The unceasing rapid trembling of the eye will blur the retinal structure itself out of the photograph, which will not be significantly confused by rods, cones, blood-vessels, etc. The user will be able to photograph anything at will, exactly as he sees it, merely by pressing the shutter on the pocket pack!

Professional news photographers will of course do wonders with their new, immediate toy. And witnesses in court, sharers of personal glimpses, and people who saw apparitions "with their own eyes" will at last be able to prove their claims. But the human sense of enduring existence will gain most of all. To capture events spontaneously, and recover visual memories just as you remember them, will give nostalgia a new dimension. And if pocket video-recording becomes possible on a small endless loop, the probe will be able to update continuously the last minute of vision, to check those panicky fears that you've just left the kettle on or the front door unlocked, or to confirm that the boss really *did* have that ominous look. . . .

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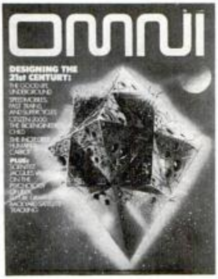

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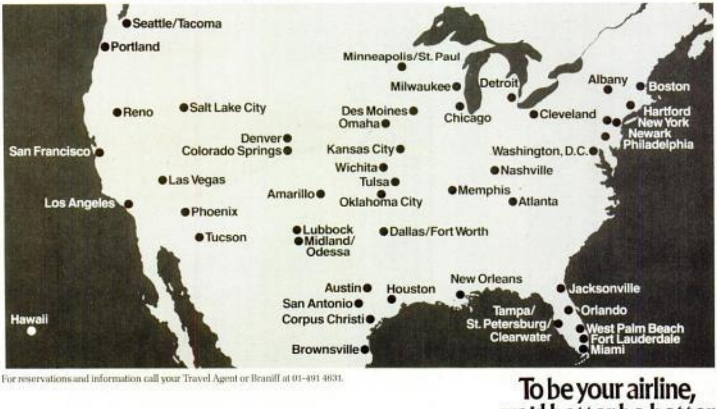

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